PAVING AND MUNICIPAL ENGINEERING

A Journal Devoted Specially to Street and Sidewalk Paving, Sewerage, Water-Works Construction, Street Lighting, and all Matters Pertaining to Municipal Engineering.

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Articles relating to the different branches of municipal engineering are desired. Stamps should accompany manuscripts for return postage if unavailable.

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The columns of this publication are open to the discussion of all subjects relating to paving, sewerage, water-works, street-lighting, and the physical improvement of cities. Practical information as to the merits of materials used in such work and new methods, with photographs and drawings, which may be used for illustration, are especially desired. We are glad to get brief notes as to proposed improvements and the letting of large contracts.

City engineers are requested to send us as early as possible copies of their annual reports, which will be given proper notice.

Articles relating to methods of road making and maintenance are invited.

LASTING QUALITIES OF PAVEMENTS.

By Louis H. Gibson.

WHO can tell how to estimate the lasting qualities of a pavement? What are the fixed conditions? The width of the street, the number of vehicles which pass over it, their speed, their character, the number of hours' service in a day, the way in which the pavement is cared for, all are varying, all have to do with the life of the pavement. We say a pavement lasts five or ten years. Would it last five or ten years some place else? Is it not difficult to indicate a parallel of conditions? The physical strain of service as outlined above, the weather, are hardly to be found alike at all times. Take, as an instance, the travel in Paris. Rue de Rivoli, 23,000 vehicles and 42,000 horses in twenty-four hours; Avenue de L'Opera, 29,000 vehicles; Boulevard Sebastopol, 46,000; Boulevard des Italiens, 30,000; Rue Lafayette, 12,000. One would not think from this that they have had quite as much trouble with Rue Lafayette as any other street notwithstanding the fact that the travel is apparently lighter than on the other streets named. It is light in one sense and heavy in others. Rue Lafayette is a relatively narrow street. The travel is concentrated. Again, it is heavy; that is, each particular vehicle will average much more in weight than those on the other streets named. Taking the weight of the vehicle, the width of the street and all into consideration, it is altogether possible that its covering has to submit to more strain per square foot per hour than that of the other streets named. It is hardly possible to affirm this positively because of the general difficulties of the problem as outlined above. Yet results on this street and the general opinion of experts indicate such a statement to be true.

STREET PAVING, AS ADAPTED TO AMERICAN CITIES.

By W. W. Thayer, C. E.

THE street paving of cities of the first class should be those best adapted, according to their durability, to the wear and tear not only of the travel to which they are subjected now, but with a view to the future popularity of the street or road and its probability of being the course of *heavy travel* or simply the *light transient travel* of two-horse teams.

I have accordingly divided my subject into

(A) *The Heavy Travel Roadways.*

(B) *The Light Travel Roadways.*

Road-bed.—In both classes, whatsoever may be the future of the pavement, the same care should be taken in the construction of the road-bed or sub-grade, as the finest pavement, however costly, is worthless when laid on an improper or unstable foundation.

The character of the sub-grade foundation or stable support for our formed roadway should be most carefully examined, the presence of springs and soft or soggy soil carefully obliterated and replaced with good hard dry earth and the whole rolled before the placing thereon of one shovelful of gravel or binder. A well-compacted road or street can not move in a lateral direction on account of its curb protection, it can not move longitudinally on account of its own stability, but it can and will move downward unless the proper care be taken in the preparation of the road-bed. The motion, if any will be uneven, causing cracks and ruts in the finished pavement, and finally be the cause of the total breaking up of the entire pavement at that point. The settling of the sub-grade at any point causes a depression of the finished surface immediately over it; this depression, when subjected to the tractive force of a wagon wheel or a hoof, will cause the adjoining stones to tip up, and we have in a short time the hole or wavy depression, so common on our city streets.

The Crown, or water shed of the roadway should appear on the finished surface only. Most specifications call for a crown in the construction of the sub-grade parallel to that of the finished grade. To this I most strenuously object. The road-bed should be excavated level and the crown formed on the finished grade entirely. I have searched and inquir d for some good reason for this common crowning of the sub-grade and can only find one thing in its

favor, and that is the question of surface drainage during construction, and we know how much the rough surface of a road-bed would lead off water on the slight grade allowed for a crown. Experience has taught us that water will not drain on a rough surface such as we would have on the sub-grade of our roadway. By the absence of the crown in the sub-grade an additional two or three inches is gained in the center of the section, where naturally the travel, hence tractive force, is greatest, and where consequently the most wear and tear will be.

The rate of fall of the crown should vary with the pavement laid. As in the case of (A) *Heavy Travel Roadways* the fall of the crown should be greater than that of (B) *Light Travel.* This is evident from the fact that in the first class, (A), a surface must be drained which in itself is not homogeneous but rather filled with solid interstices adapted for the adhesion of an animal's hoof in the hauling of heavy loads, while smoothness of surface is the aim on (B) *Light Travel Roadways.*

TABLE OF FALLS OF CROWN FOR VARIOUS ROADWAYS.

Pavement.	Fall not more than	Fall not less than	Average fall per 100 feet.
Stone Block	6 in. in 13 ft.	3 in. in 13 ft.	2.00
Asphaltum..	6 in. in 15 ft.	3 in. in 40 ft.	1.34
Brick.....	6 in. in 10 ft.	3 in. in 20 ft.	2.46
Macadam...	6 in. in 10 ft.	3 in. in 30 ft.	1.85
Gravel.....	6 in. in 10 ft.	3 in. in 30 ft.	1.85

(A) *The Heavy Traffic Pavement.*—Such paving should be adopted for this class as is suitable only for the constant wear and tear of the heaviest kind of travel. The pounding of large bus lines, loaded drays, and three horse carts, together with the constant rumble of light carts, wagons and conveyances of every description. A cart with its dead load averaging 6,000 pounds gives us conditions which are somewhat different to the ordinary buggy or double Germantown wagon, as in the case of the former we are nearing the crushing limit of our surface metal. Of this class the paving should be of stone block surface, either

(1) Guidet or concreted foundation block pavement.
(2) Russ or patent section pavement.
(3) Belgian or granite block pavement.

What is most sought for in this class of paving is an even surface, with good foothold for horses, one thoroughly impervious to water and self-draining, and a pavement where stability will reduce the loss of original surface to the minimum. That is one, where the tractive force will be least with the greatest adaptability of foothold without permanent injury to the roadway.

The Guidet pavement consists of the ordinary granite block laid on its side on one inch of sand and on a bed of six (6) inches of concrete thoroughly rammed. As the durability of this roadway is evidently dependent on the concrete layer it is more than evident that if perfection is reached in this alone, the sub-grade must take all the responsibility and be most carefully prepared as the sinking of any part will make the part above worthless. The cost of this pavement is approximately as follows for one square yard:

26 blocks, trimmed edges, at $11.00 per C.....	$2 86
1 square yard of concerete at $9.00 per C. yard	1 50
Excavation of roadway ± 6 inches deep.....	10
Labor of laying and ramming.....	50
Cost per yard, complete	$4 96

This is exclusive of excavation over six inches and allows a basis of two per cent. profit.

The Russ pavement is one which is designed more especially for the purpose of lifting out sections, to get at water or gas pipes, etc. It consists first in ramming granite chips about five inches in diameter into the road-bed and flushing them with top of same flat side up. A concrete foundation is then laid in frames of sound wood, thicker at the bottom than at the top, by means of which the block of concrete when hardened may be lifted from its position, for access to the underground structures. On the top of this is then laid the block as before, the interstices well filled with sand or fine gravel. I know of only one instance where the pavement has been laid, and whether it was through inexperience or not, I can not say, yet it has now been entirely removed and pronounced a failure.

The cost of this pavement is as follows, per square yard:

Spawls 5 inches in diameter and 3 inches deep, including placing by hand and thorough ramming...	28
One square yard concrete 6 inches thick, made in hard wood frame, at $15.00 per C. yard.....	$2 50
One square yard of sand 1 inch deep	06
Sand for interstices	05
30 blocks 10 inches by 4 inches, including laying, and 10 inches deep, at 11 cents.....	3 30
Cost per square yard, exclusive of excavation...	$6 19

Belgian: (*a*) With gravel joints.
(*b*) With pebble and pitch cemented joints.

(*a*) This pavement, the most commonly used, and the most economical of durable pavements, consists of Eastern granite blocks about 10 by 3½ by 7½ in size laid on a gravel bed of 6 inches depth, which has been thoroughly rolled and brought to a uniform grade, the interstices being filled with gravel, the blocks at once rammed with a fifty or sixty pound rammer and the whole covered with a layer of fine soft gravel.

(*b*) In this pavement the same bottom course of sharp gravel is used on which is placed one (1) inch of clean, dry sand or very fine, clean gravel. On this the blocks are placed and the interstices filled with clean, hard quartz pebbles and the whole thoroughly rammed as above. The loose pebbles are then swept off and the cracks filled with hot paving pitch applied in liquid form until they will receive no more and the whole covered with one (1) inch of clean, hard, sharp sand. The difference in the cost of these two pavements is only an additional cost of the pitch and the pebbles in the case of the latter, which would be about twelve cents per yard.

The cost per yard of the (A) Belgian block pavement with gravel joints is as follows:

28 blocks at 6½ cents	$1 82
Gravel	10
Labor of laying, etc.....	36
Cost, exclusive of excavation per yard, complete.....	$2 28

These pavements are those best adapted for the heavy traffic of large cities for the reason I have already stated and trust their approximate costs will be of interest and perhaps of use.

(B) *Light Traffic Roads and Streets.*—Should be either (1) sheet asphaltum, (2) asphalt blocks, (3) brick, (4) macadam or Telford, (5) wooden, (6) gravel. The much and deservedly abused cobble pavement being considered unfit for city use I will not touch on, except to say that they are a good feeder for the stone breaker and make excellent binders for the sheet asphaltum.

Sheet Asphaltum.—Its advantages are, that it makes a noiseless, self-draining, impermeable, free from vapor roadway, with a great reduction of the force of traction on account of its smooth surface; yet on the other hand its disadvantages are great, being greatly affected by change in temperature, affording little or no foothold for horses, being dusty in hot weather and slippery in wet weather; extremely hard in cold weather, while under the rays of an August sun it is soft enough to leave tracks and emit an odor extremely disagreeable; extremely pleasant to drive on but correspondingly unpleasant to walk on when warmed by the sun. I have seen experimental tests by trotting horses on asphaltum which have convinced me of its deleterious influences on horses. A horse was trotted at about seven miles an hour over one mile of asphaltum, with the thermometer at 92 degrees in the sun. At the end of this mile I was hardly able to retain my hand on the base of the animal's hoof, so great was its temperature. I have seen horses trotted over macadam, cobble, gravel and brick pavements under the same conditions and the difference of temperature of a horse's foot noted

with only a slight increase of temperature, hardly perceptible. The asphalt block has also this power of heat absorption, but not to such an extent.

The method of construction consists of a base of broken three and one-half inch (3½) ring stone laid four and one-half inch (4½) deep and rolled into place and thoroughly coated with hot paving cement composed of coal tar distillate. On this is placed the binder course two (2) inches thick, composed of one and one-half inches (1½) heated and covered with coal tar distillate and spread evenly and rolled with a steam roller. The wearing surface is composed of a mixture of refined Trinidad, heavy petroleum, fine sand and powder of carbonate of lime, and is laid with a temperature of about 200 degrees Fahr. and the whole swept with Portland cement and again rolled with a steam roller. The gutters are coated with vulcanite and smoothed off with hot irons so as to make a thoroughly water tight connection with the curb.

The necessity of making this pavement impermeable to water is evidenced from the fact that when hardened it will rot from water from below and the road-bed under the finest layer of stone if washed by water will produce the same results as mentioned above in block paving, namely, will cause the finished grade to settle and break. I am convinced that the advisability of sheet asphaltum is dependent upon the character of the climate, so different is our climate from the great cities of Rome, Vienna, Bremen, Paris, London, Brussels and other foreign cities of street fame that no comparison can be made between the durability of the same pavement laid here and across the water. The streets of Washington are not subjected to the heavy travel of cities of the first class, it not being a commercial center, and moreover the prices paid for asphaltum pavements there have cost $4.25 per yard instead of $2.30 and $2 60 here per yard. In the large cities, like Philadelphia, New York, Boston, Chicago, etc., the same cause of complaint arises from asphalt pavements, that is the rutting or wave like holes forming which are caused not so much by an error of construction as by an actual working of the component parts of the asphaltum, caused by the heavy traffic at a time when the pavement by the rays from the sun has reached a certain degree of heat, which makes it theoretically pliable or elastic.

The ignorance of municipal engineering is more apparent in this pavement than in any other. I have seen pavements of asphaltum where the whole street was asphalted excepting the (2) two feet adjoining the gutter on either side. This was laid with blocks. In other words, the place where impermeability to water should have been most sought for, and which in the hands of skilled workmen is carefully laid with Trinidad and ironed by hand, there is placed a pavement of such a character that access to the sub-grade by water is encouraged rather than guarded against. The settling of this asphaltum is apparent all along the gutter.

Lieutenant Gillmore, in his treatise on roads, says of asphaltum paving: "A four-wheeled truck weighing three tons, carrying a boiler weighing twenty-one tons passed over a piece of asphalt pavement in Fifth avenue near Twenty-fourth street, New York, without leaving any mark!" He, however, does not mention the thermometer on this day, but I think had it been 90 degrees, F., it would have gone through and had it been 30 degrees, F., twice that load might have passed over without cracks. This author recommends also concrete foundation of beton in all cases, when it is the general opinion among engineers and road builders that the broken stone and coal tar distillate is far preferable.

(2) *Asphalt Blocks.*—The manufacture of this block is far from perfected, the trouble being that the edges of the block chip off and constantly wear away until a round stone is left only a little better than a cobble stone. Then, too, the price of the asphalt block is as high, if not higher than the granite block and will last only one-quarter of its time, so that until a more improved block is made for street travel they can not become of general use.

(3) *Bricks.*—The vitrified brick pavement has had its boom and sample pavements can be seen in many places. This pavement is laid on Juniper street between Chestnut and Sansom streets in Philadelphia and speaks for itself. It possesses the same defect as the asphalt, breaking off and crumbling under travel and soon becoming like a stone pavement.

There are many streets paved with brick in the northwest section of Philadelphia, many of which are too new to judge of as yet, while the older ones are in some cases as bad as Juniper street. The cost of this pavement is from $1.40 to $1.65 per square yard.

(4) *Macadam and Telford.*—This pavement is unfit for municipal works except in cases of suburban districts or where a handsome drive or boulevard is desired, when police protection must be used to keep off heavy traffic. A glance at Twenty-second street in Philadelphia will show the folly of such a useless expenditure of money.

(5) *Wooden.*—I regret most extremely that I have had no practical experience with wooden pavements. Their advantages seem to be less wear and tear on tires and horses, less noise and smooth traction; their disadvantages, slipperiness in wet weather, and their power of absorption of animal excrement which gives forth unhealthy odors when subjected to drying. The kinds of wood, methods of setting and modes of preparation for preservation are so numerous I will not enter into them here but suffice it to say that from its perishable character and inability to stand heavy traffic we do not desire to risk money in this changeable climate in a pavement we know has failed in so many cases to answer the demands thrust upon it.

(6) *Gravel.*—These roads of red gravel are suitable only for park purposes and not municipal travel. Its advantages are a smooth, hard, impermeable and less tractive surface at a low cost, capable of standing the ordinary light travel of carriage under the proper care of watering and general maintenance. Gravel roads should be drained in all cases with stone or block gutter as a gravel gutter will eat away and soon destroy the edge of the roadway.

I have purposely avoided discussion of macadam and Telford roads as I have said above as not coming under the class of street paving herein discussed. A golden opportunity awaits the man who invents the ideal city pavement; that is, one possessing the necessary essentials of smooth surface capable of sufficient adhesion to afford tractive power a minimum, impermeable, clean, durable and capable of resisting very heavy dead-load loads, and above all, economical. Certainly we are further from this now than were the ancient Romans.

MANUFACTURE OF PAVING BRICK.*

By F. M. Spalding.

A PAVING brick must be of such density as to be practically impervious to water, and consequently not subject to the action of frost. It should also possess toughness and tenacity to such a degree that the edges will not break off and that the surface of the brick will not wear rapidly when exposed to heavy traffic. A tough, thoroughly vitrified brick possesses these qualifications, as it combines imperviousness to water with great strength and durability.

The shale clay used in making terra cotta pipe generally will make good vitrified brick. A strictly pure clay, that is, one which does not contain any alkalies, is not desirable, as it should not only be able to stand a very high temperature, but should also contain some fluxing agent which will vitrify the brick. The presence of any considerable quantity of lime is particularly to be avoided, as it will cause the brick to disintegrate and scale. At Galesburg the clay is taken from a bluff, and although it resembles sandstone somewhat, it is almost entirely free from grit. Along the Ohio river, shale and coal are taken from the same mine. At present fire-clay is extensively used in the manufacture of paving brick, yet the best results are obtained when it is first mixed with some other kind of clay, since it is almost impossible to vitrify fire-clay. One prominent engineer gives the following as the average composition of paving clay: 69.1 per cent. silica, 15.5 per cent. alumina, 5 per cent. chemically combined water, 2 per cent.

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*Read before the Civil Engineer's Club of the University of Illinois.

moisture, 2.5 per cent. iron, 2.5 per cent. magnesia, and 3 per cent. of lime.

The practice of weathering clay has been extensively followed and has proved to be very beneficial, yet in most larger factories tempering machines are now used instead. During the process of weathering, the clay separates into fine particles so that the contact is very intimate when it is finally made into a brick, hence the brick will be dense and contain very little moisture. The clay must be well mixed and tempered before it is sent to the brick machine. There are three methods of accomplishing this, the soft mud, the stiff mud, and the dry pressed. The average clay can be worked most advantageously as a stiff mud, hence this process is extensively used. In one form of this process the clay is placed in a large iron dry pan as soon as excavated, and then crushed by means of heavy revolving rollers, into powder, when it drops through the perforated bottom of the pan on a carrier which takes it to the tempering machine. Here it is moistened just enough to make a stiff mud. In another form of the stiff mud process the clay is taken directly from the bank and dumped into a pit, where it is thoroughly worked over by men with spades, then while still in the moistened state it is passed through a crusher and carried directly to the machine. In the soft mud process the clay is placed in a large circular vat where it is mixed into a soft, pasty mass by a rotating wheel having two motions, one along and one around its axis. In either method the clay is now ready for the machine. The dry pressed process is very rarely used for paving brick.

The brick machine should compress the clay the utmost possible amount. The softer the clay leaves the machine the greater will be the shrinkage from drying and burning, and also the greater will be the loss in handling. With the stiff clay process the clay is forced out of the machine in a continuous bar, which is cut off as it leaves the machine by means of wires strung in a frame which works either automatically or by hand. The brick may be either side or end cut. In the soft mud process the clay is forced into molds, which are removed as fast as filled.

The next step is to dry the brick. While some of the old-time brick-makers still persist in using the sun as their only means of drying, the majority of intelligent brick-makers use some form of artificial drier. In one form, which is frequently used, there are coils of steam pipe under a slatted floor. The brick are loosely tiered up on this floor, and are dried by the radiation of the heat from the steam pipes. In another form the floor itself is heated by means of brick or tile flues, the brick being dried by direct contact with the heated surface. In the tunnel drier the brick are placed on iron cars and run into the tunnel, and heat and smoke allowed to pass directly through the tunnel. The brick are completely dried in the tunnel drier in twenty-four to thirty-six hours. Sun-dried brick are usually only partially dried when placed in the kiln, which necessitates a great deal of water-smoking. A prominent brick-maker says: "It costs from one dollar to two dollars per thousand to dry brick in the kiln, and the result is second or third-class brick; while the brick can be thoroughly dried before being set in the kiln for twenty-five to fifty cents per thousand, and the result is first-class brick."

The last and most important step is the burning. There are two classes of kilns, the up and the down draft. The up-draft kiln is simply a great rectangular pile of brick tiered loosely, with the exception of the outside courses, which are laid solid with mortar. The top is left open to permit the heat and smoke to pass off. The fires are built under the kiln on all sides, and the heat and smoke passes up through the brick and out at the top. This kiln can be used but once, and a new one must be built for the next lot of brick. It is not so generally used for burning pavers as the down draft. The most popular form of the down draft is the Eudaly. This is a permanent brick structure having twenty-four-inch walls and a thick brick arch top. It may be built either round or square, and the capacity varies from twenty-five to two hundred and fifty thousand. There are furnaces all around the outside of the kiln, and within the walls of the kiln at frequent intervals are small chimneys extending from the flues below the floor to a few feet above the crown. The heat and smoke from the furnaces pass through the walls of the kiln into fire boxes which conduct the heat to the top of the kiln before coming in contact with the brick. The heat then passes down through the brick and out of the perforated bottom into a system of flues which connect with the small chimneys. Each chimney is provided with a damper so that the heat may be shut off from any part of the kiln, thus placing the kiln under perfect control. It usually takes sixty hours to water smoke, and from four to six days more to finish the burning. The amount of coal consumed per thousand brick varies from 600 pounds to 2,000 pounds, according to the character of the clay and the quality of coal. A number of brick-makers are using oil or gas fuel in firing their kilns, claiming that it makes a cheaper fuel and one which is more easily regulated. The time required in burning pavers is slightly more than for burning common brick, owing to the increased length of time which the heat must be held for vitrification.

The process of vitrifaction is as follows: "Clay is a silicate of alumina with foreign admixture of sand, iron, lime, magnesia, and alkalies. Under the action of heat the alkalies melt, and at the same time the lime, iron, and magnesia begin to act as fluxes. Continue to increase the heat and the solvent action increases. When all the particles have become impregnated with the melted portion we have reached vitrifaction." A uniform temperature must be maintained, and if the burner finds one part of the kiln is vitrifying faster than another, he must retard the heat in that portion. The temperature required for vitrifaction is 2,000° to 2,500° F. The kiln must be allowed to cool very slowly, as it is the slow cooling which tempers the brick and gives it the required toughness. From seventy-five to ninety per cent. of the brick placed in the kiln are fit for pavers, and nearly the entire remainder can be used for building brick.

THE VENTILATION OF SEWERS.

MR. CHARLES BAILLARGE, the distinguished city engineer of Quebec, addressed the Royal Society of Canada, at its meeting in Ottawa, on May 31st, on the subject of the free and liberal ventilation of sewers, in its relation to the sanitation of dwellings. In the course of his address he said:

"The advocates of sanitation, nowadays, go too far in demanding the ventilation of sewers by such expensive processes as the erection of tall chimneys here and there, and the establishment of fires or of foci of heat and suction at numerous points in every city of the old and new worlds; and the last scheme in this direction is that of MM. Peek & Hall, who in a seventeen page article published in the *Contemporary Review of London*, for February, 1892, are trying to convince the people, the authorities, that they must of necessity tax themselves to erect expensive towers here and there, wherewith to create the necessary draught as in coal mines, to ventilate the London sewers, and thus, as they pretend, eliminate the deleterious qualities of the London fog made nocuous by the emanations from them; notwithstanding that these fogs have existed from time immemorial, and are no doubt due to atmospheric causes with which the warm sea breezes from the 'Gulf Stream' may in some way be connected.

"No, these emanations from the sewers are by no means as noxious as they are said to be, and to proof: there are those who, so to say, inhabit them and pass their lives in cleaning, scouring and emptying them.

"See the Paris sewers: I have been in and through them on a visit of inspection lasting an hour or more, and that, in the company of a party of ladies and gentlemen from England, Germany and elsewhere. The Paris sewers can be thus visited once a month under a permit to be obtained on application at the 'Prefecture de la Seine,' and if it does not take place oftener, except on special permission to some person of rank or who can only make a short sojourn in the city, it is that too frequent interruptions of the kind would materially interfere with the duties of those who are charged with their daily scouring out and cleaning.

"True, the cess-pool system holds in Paris, and night soil or excreta do not find their way into the drains, because as an economical feature they are retained to be utilized for manuring purposes, and are during the dead of night pumped by suction into large cylindrical receptacles on four-wheel trucks and driven out of Paris to be disinfected and turned into what is known as poudrette. But even if these matters did find their way into and through the sewers when freshly produced, *i. e.*, before decomposition of them sets in, and borne away as they immediately are by the flush and rush of water from a w. c., their presence in the sewers would add but insensibly to the emanations from the urines of man and animals, domestic waters, liquids and other products from tanneries, factories, industries of all kinds, chemicals and dirt of every description which, in a city of two and a half millions of souls, are every day poured into the sewers and driven through them uninterruptedly throughout the year.

"Now all of us with a voice, after entering the sewers at the 'Place de la Madeleine' and emerging from them at the other end of Paris; all of us, I say, agreed in admitting that the most delicate olfactories had experienced nothing disagreeable—nothing more, in a word, than a slight sensation of closeness as on entering a bedroom in the morning or a house for some time untenanted.

"And why no smell, nor anything approaching even to it? The sole and abundant supply of water poured into the sewers from the street hydrants opened every morning to cleanse the gutters or water channels of the balance of the dust swept into them, after removal—during the early morning, and before the shops and stores are opened—of the bulky material—scraped and swept together into heaps during the small hours of the night—to the city dumping grounds, in tumbrels provided by the municipality.

"The waters already alluded to, as well the waste from taps and other sources, and occasionally those from rains and storms; all these together, run along as a tiny river at the bottom of the sewer, in a channel eight feet wide and some four feet deep, formed in the 'Grand Collecteur' of sixteen feet in width and ten feet high, under the Rue de Rivoli, by the double four feet cut stone side-walks on which two men on either side trot along and thus by means of a projecting bar propel the boats containing the excursionists.

"The sewers of secondary size, which empty their contents into that just described are only ten feet in width, with a six foot channel between sidewalks two feet wide, and on either side thereof is laid a rail along which a series of cars, again propelled by hand by men told off for the purpose, one on each side the channel, ride smoothly along above the flowing waters. The sewers third in point of size are six feet wide with a sidewalk on one side only; and one and all of them are thoroughly lighted up with gas or oil and will now shortly be, if not already done, by incandescent electricity.

"The quantity of water in the sewers is such as to dilute, in the ratio of say 100 or 1,000 to 1 every particle of absolute sewage or excreta passing through them and which might otherwise prove noxious; and they are absolutely without danger to the host of employes who may be said to pass their lives within them.

"Fifty or a hundred years ago I would not have suggested what I now favor for cities and towns in general; but where at present is the community of any importance in the old or new world, which has not its acqueduct, its abundant supply of water, and in such abundance as to be in bulk a thousand or ten thousand times that of all the filth to be removed, and such as to render it absolutely inoffensive, as far as any smell or noxious gases from it are concerned.

"Like Don Quixote who created wind mills, then to war against them; it is that terrible word 'sewer gas' which after thus wrongly styling it, we are afraid of and endeavor to combat by the most expensive means, in no way called for and out of all proportion with the evil to be done away with.

"'Sewer gas' is nothing more than ordinary atmospheric air slightly contaminated by its admixture with the gases which are formed by the decomposition of the sewage matter, as well by the organic germs which these matters hold in suspension: microbes and bacteria, etc.

"It is equally certain that the would-be-dangerous character of these gases is reduced, if not entirely eliminated, by their free exposure to the oxydizing action of the air. A more serious danger is that in certain cases of sickness these products are charged with specific germs, and require to be promptly destroyed or removed by gravitation after being sufficiently diluted with water.

"The gas called 'sewer gas' has no existence, or at least it does not necessarily exist or in spite of our endeavors to prevent it; and if it does exist, it is because we will it so, since it is so easy to get rid of it, or rather to prevent its formation by conducting it immediately and continuously into the admosphere by the proposed ventilators along the center of each street, and as already stated directly over the sewers to be disinfected. Once more, this gas is nothing but atmospheric air, which under its normal and ever active pressure, penetrates the sewers as it does our houses and our lungs.

"I have just said that the liquid and solid excreta, when freshly produced and undecomposed, are absolutely inoffensive, with the exception of those of certain diseases, but which, mixed with normal excreta or of persons in health, rarely count for more than one in a thousand or even in ten thousand, as at present in Quebec, for instance, where there are, or were at the time of writing this, eight cases of diphtheria to a population of 80,000 souls.

"These excreta, I repeat, are inodorous, innoxious while in the water in which they were deposited, and continuing their course in full water towards the sewers and in full water through the sewers and until their expulsion into the river, lake or sea, as the case may be, and the time of this trajectory or passage to an outing, not generally more than an hour or two in riparian cities like Toronto, Montreal, Quebec, Ottawa, Hamilton, etc., or cities through which rivers pass, as in the case of London or Paris, etc.; decomposition does not set in during such a brief period of time, nor would it do so even if the time of passage were many times as great.

"Another proof that these substances are inoffensive is, that it has been demonstrated that the fears entertained that sewage-irrigated lands would prove detrimental to health have been entirely dissipated, their sanitation being entirely effected by the oxydizing power of the air.

"Admitting now for an instant, that human excreta do under some circumstances prove slightly disagreeable to the olfactories, they are not, for all that, the more noxious in a sanitary point of view when of recent production; no more than are the fumes of a variety of substances which without being agreeable to the sense of smell, as of coal oil for instance, are none the more deleterious for that.

"I therefore conclude from the premises recited, that for any city having an acqueduct and a regular and proper system of drainage, that is to say, sewers of proper ovoid section, and therefore narrow at the base or invert, so that the water may flow through them under as great a head or depth as possible, and with an inclination proportional to the depth of water; such sewers can be ventilated in the way set forth without giving rise to emanations in the slightest degree anti-hygienic, or even more pestiferous than those of every day life which we can not escape, as of the excreta of horses and the like.

"It is moreover known that a rapid or active run of water in a sewer creates a friction at its surface which drags along with it a certain stratum of air, which in its turn gives motion in the same direction to a second stratum, this to a third and so on until the whole body of air above the water in the sewer is set in motion towards the outlets of the system and thus expelled: contributing thereby in a considerable degree to effect the ventilation of the conduits."

J. W. PENFIELD & SON, of Willoughby, O., have issued handsomely-printed circulars, explaining the operations of their auger brick machines and automatic cutter and of their taper tub pug mill.

BOSTON'S STREET PAVEMENTS.

THE annual report of the street department of the city of Boston for the year 1891 is one of the most complete ever issued by an American city. It gives full information regarding not only the work, but the needs of the city, in the different departments, and all is set forth comprehensively and impressively. It is altogether well near a model report, and is put in worthy form, comprising a volume of nearly 400 pages, well printed, freely illustrated and substantially bound in cloth. We regret that the report itself does not indicate to whom the credit of the work is due, though much of it, we believe, may be ascribed to Henry B. Wood, executive engineer; Henry H. Carter, superintendent of streets, and Charles R. Cutler, deputy superintendent of the paving division.

The report shows that the streets of Boston and suburbs are now paved as follows: Asphalt, 4.66 miles; block, 69.29; brick, 0.36; cobblestone, 5.94; Telford and macadam, 204.56; gravel, 139.48; total, 434.59. Regarding the condition of the streets of Boston and the work hereafter to be done the report says:

"The inferior condition of most of the paved streets of Boston is apparent to every one. Several causes have operated to bring this condition about.

"In the first place, the quality of the stone blocks with which the pavement was originally laid was poor; these blocks, in most instances, were roughly cut, of irregular dimensions, and laid without proper care, so that, in some cases, even where the original pavement has been disturbed, it has worn unequally and has settled in such a manner as to present a very uneven surface.

"The numerous structures under the pavement, consisting of gas pipes, water pipes, telephone conduits, steam-heating pipes, electric wire conduits, and sewers with their connections, necessitate a constant tearing up of the pavements to make connections and remedy breaks and defects.

"There is also the tearing up and replacing of railroad tracks, which is continually going on. This continual disturbance of the pavement and the impossibility of replacing it over an excavation in such a manner as to leave the pavement in its original condition, has resulted in the present uneven appearance of many of our streets, making them uncomfortable to travel over and difficult to clean.

"It will be impossible to construct and maintain first-class pavements in our commercial and business thoroughfares, as long as private corporations are allowed legislative franchises to not only cover the greater part of the surface with railroads, drip-boxes, manholes, gate-boxes and covers of all sizes and kinds, but also to undermine the same with a perfect network of contrivances, some seething with steam, some flowing the most volatile, gas-producing and inflammable hydrocarbons, and some conducting the electric current—all being liable to get out of repair and requiring excavations and disturbances of the street-surface to keep them in condition.

"The spirit of self-interest and the desire to realize large dividends tend toward the greatest economy on the part of corporations in replacing the disturbed portions of street and pavement; thus leaving to the city a great deal of work to finally adjust and regulate at the expense of the public funds.

"The only complete remedy for these evils is to build a large brick subway beneath the sidewalk or roadway capable of containing every wire or pipe needed for all purposes, with only its manholes appearing at the surface.

"Until such time as an underground conduit of a size sufficient to contain all gas, water and other pipes and wires is laid, it will be impossible to prevent the tearing up of the pavements, and dependence must be placed on the power of the department to grant or refuse permits to have all openings repaved in as good a manner as possible under the circumstances. The amendment to the ordinance made this year, whereby the parties who make openings are obliged to keep the pavements in repair for six months, and, on their failure to do so, to be obliged to pay the cost of the city's doing the work, will tend to lessen these evils.

"Eleven thousand, three hundred and twenty permits were granted during the past year to open streets. The excavations made under these permits aggregate 110.7 miles in length, and show the proportions to which this nuisance has grown.

"One thousand, nine hundred and sixteen openings were made under 'emergency permits' for breaks in water and gas pipes requiring immediate attention.

"Boston has a larger proportion of macadamized streets than any large city in this country. While streets of this description can be constructed cheaply, the rapid deterioration of the surface requires an immense outlay to keep them in repair. With constant attention in the way of re-surfacing and watering these streets are convenient for travel, but without this care, holes are soon worn in the surface. Macadamized streets are always muddy in wet weather, and are not suited to stand the travel of our thoroughfare leading to the suburbs.

"All the macadamized streets of the city proper, except those whose grade is more than 6 per 100, and all the main macadamized avenues which radiate to the suburbs, should be paved with granite blocks, or asphalt, as rapidly as the finances of the city will permit.

"In determining the character of the pavement to be used on a street, regard must be paid to several conditions, among which are its life, first cost, cost of maintenance, convenience, appearance, and adaptability to the traffic it may be expected to undergo during its life.

"The pavement laid this year has been laid in accordance with the best modern practice, and in accordance with what seemed for the best interest of the community.

"The business streets in exclusively commercial sections subject to the heaviest travel have been paved with granite blocks.

"Where all water, gas, sewer, telephone, and other pipes, are already laid, and where there is reasonable cause to believe that the pavement will not be constantly torn up, the blocks have been laid on a concrete base of hydraulic cement and the joints filled with pebbles and road pitch.

"A concrete base is especially applicable in loose soil where there is liable to be trouble from subsoil water.

"The streets subjected to heavy travel in which the various pipes have not yet been laid, have been paved with granite blocks on a gravel base in the ordinary manner; more attention, however, has been paid to rolling and preparing the foundation-bed than was the practice in former years, with the result of securing a more even pavement.

"The residence streets, where sufficient appropriation existed, have been paved with sheet asphalt, asphalt blocks, or brick, as seemed most suited to the case in hand.

"Brick paving has only obtained on a few cross-streets, with a view of putting it to a thorough test. It can be used to advantage on streets of comparatively light traffic, where a less expensive form is desired than asphalt.

"It is believed that the above kinds of pavement include all the varieties necessary to pave our streets in a first-class manner. Wood pavements, which are extensively used in Western cities and the cities abroad, are not adapted to this city. The difficulty of keeping them clean, owing to the tenacity with which filthy matter of all kinds adheres to them, and the exhalations which arise from their absorption of fluids, render them an unsanitary pavement. They are short-lived and require frequent repairs.

"The granite block pavement, laid on a face of hydraulic cement concrete is believed to be the pavement best adapted to our business streets, especially where all water, gas, telephone and electric pipes have been laid and connections made. This pavement possesses the advantage of the longest life, is easily cleaned, gives a good foothold for horses and requires but little expenditure for repairs. Its chief disadvantage is its noise. The average cost of this pavement, including all labor and materials is $4.70 per square yard. This pavement has been laid on Tremont street, between Cornhill and Boylston street, and a comparison of the paving between the railroad tracks with the rest of the street shows what can be done with first-class granite blocks properly laid.

"A number of streets have been paved with granite blocks laid on the ordinary gravel foundation. This style of paving has obtained on such streets as were not entirely built up with business blocks, and where a subsequent change in the character of the buildings will involve numerous excavations to connect with water, gas, electric, and other pipes. The quality of the stone blocks used has been first class, however and when the street has arrived at its ultimate development (provided it does so during the life of the stone blocks), the street can be paved with the same blocks set on a concrete base.

"A large amount of asphalt paving has been laid this year on different streets, among which may be mentioned: Beacon street from Charles street to Arlington, Cabot street, Columbus avenue, Hudson street, Austin street, Kilby street, Court street, etc. This pavement is particularly suited to residence streets, and such business streets as are free from horse-car tracks and are lined with buildings occupied mostly by offices, where the noise of a granite block pavement could not be borne. This pavement, when made of genuine asphalt and prepared and laid in the best manner, gives a very satisfactory result. Such of these pavements in Boston as have given out have done so by neglect to promptly repair them, or else by the opening of trenches through the street for the various gas, water, or other pipes. The life of the pavement is not so long as that of a granite-block pavement, but with reasonable care the pavement is good for many years. All the asphalt pavements laid are kept in repair at the expense of the contractors for five years. The asphalt pavement is easily cleaned, and presents a pleasing appearance to the eye. Much has been said and written about the slipperiness of this pavement. If the pavement is kept clean and free from the thin coating of mud which is apt to accumulate, and is sanded in case of sleet falling on the surface, it gives a better footing than a stone pavement. Statistics prove that more horses fall on a mile of stone pavement than on a mile of asphalt pavement. The cost of the asphalt pavement laid this year has averaged about $3.50 per square yard.

"Several streets have been paved during the year with an asphalt block pavement. This pavement, while not so durable as the sheet asphalt, has the advantage of being easily replaced in case of excavation being made through its surface for gas or water pipes. It presents a very handsome appearance when well laid, and is well suited for light travel. The city of Baltimore has miles of streets paved with this material, which have been in good repair for eight years.

"The use of brick for a street pavement has been attracting the attention of municipal authorities for the last few years. It is extensively used in several western and southern cities, and has lately been tried in some of the large cities, among which are Cleveland, Columbus, Chicago, Philadelphia, Indianapolis, Omaha, Peoria, Baltimore, Washington, Harrisburg, Wheeling, Johnstown, Clinton. The claims made for this pavement are its low cost, combined with its durability and appearance. There are now four streets paved in this city. Hamilton Place (a private way) was paved in 1888 by the abutters, and is now in good condition. It is subject to light travel only, so that conclusions can not be drawn from this street alone concerning the durability of the pavement. Genesee, Seneca, and Oswego streets have been paved with brick this year; the first two streets with a Keramite brick, at a cost of $2.75 per square yard; the last-named street with a brick manufactured in Rhode Island, at a cost of $2.40 per square yard.

"The following method was observed in paving streets. The macadam was excavated to the depth of seven inches and the roadbed then rolled with a horse roller. A two-inch layer of gravel was then spread and rolled and the bricks laid on a thin sand bed. After being rammed in place, the surface was flooded with water and the bricks again rammed to a true surface, after which the joints were grouted with Portland cement mortar, mixed one to one. These streets have only been paved six months, so that no judgment can be passed upon them.

"There are various methods of laying a brick pavement, and it is proposed during the coming year to lay the bricks on a concrete base as well as by other methods, so that a comparison may be obtained. Great care has to be taken in the selection of the brick to be used, and before trying this style of pavement, the department made a series of tests of different bricks submitted.

"The brick should have toughness, elasticity, homogeneity and impermeability, and this condition should obtain in each and every layer throughout the kiln."

FOUNDATIONS FOR BRIDGES.*

By P. Mogensen.

PROBABLY one of the most varied subjects submitted to the consideration of civil engineers, is the design and construction of bridge piers. From the simple wooden trestle and the equally simple crib built of ties and used for temporary purposes, to the gigantic pier of the Firth of Forth bridge innumerable graduations are found, and in many cases the engineer is called upon to overcome seemingly insurmountable difficulties in connection with such works. It is far beyond my power to treat of any part of the more intricate structures; my object is merely to call attention to a few simple details in the construction of masonry foundations in shallow rivers where underground water is encountered, or in other words, where pumping is required.

The surface water is often a source of great trouble, and claims the attention of the constructing engineer as soon as the location of a bridge has been fixed, especially if a stream is found running where excavations are to be commenced. To make the position of one or more piers accessible, it will generally be found convenient to divert any such stream. It is not essential that the diversion be made close to the bridge; it may be effected where it can be done at least expense. However, as such diversions generally require dams, it should be within a reasonable distance for easy inspection.

When the river bed consists of sand, a secure foundation may be made by sinking cylindrical wells to a depth of say twenty feet, but in all cases lower than any underground current that might be met with. The depth to which the wells must be sunk, naturally depends upon the resistance offered by the sand, the number of wells employed, the weight they are required to support, and other considerations.

Where a large pump is required, the inside diameter of a well should not be less than six feet, or large enough to enable two men to work alongside the suction-tube. The wells should be built of bricks and cement mortar, to a height of about ten feet above ground before the sinking of them is commenced. A strong wooden frame should be placed under each well and another on the top of the section built, both being firmly fastened by strong bolts passing through the brick work. The top frame may be removed when it is required to add to the well.

Whatever the number of wells in a pier, they should be sunk simultaneously. This is done by loading the top frames with long, heavy objects such as rails, girders, etc., for the purpose of forcing the wells down when the material underneath the bottom frames has been removed. If the amount of water flowing into two or three wells does not exceed the capacity of one pump, the water should be drawn from a well sunk somewhat deeper than those adjoining, which are by this means drained. The excavated material is taken out with a small windlass.

The pump should be fastened to a wooden frame, placed on the top of the objects used as weights. A derrick with blocks and tackle should be erected over the pump and kept in readiness for raising the suction tube whenever the foot-valve fails to act. If a sliding suction is used, it should hang supported in the pulleys. Sometimes the pump may be entirely dispensed with. The wells are then excavated by means of grab-winches, the buckets of which fill automatically when let drop on loose material. It is needless to say that this method will be impractical when stones of considerable size, trunks of trees, or other obstructing bodies are encountered.

*Read before the Civil Engineers' Club of University of Illinois.

When the wells have been sunk to the required depth, they should be filled with cement concrete up to ground level, where neat work may conveniently be commenced. Small arches should be built to support the body of the pier where it overhangs the openings caused by the curvatures of the wells.

Instead of brick wells iron cylinders are advantageously employed where they can be procured at a relatively low price, and especially where a large diameter is required, as in this case the brick wells are liable to collapse. The iron cylinder has the further advantage of presenting a smaller annulus to be cleared at the bottom, and having a smoother outside surface its own weight is often sufficient to force it through the ground. The methods of sinking iron cylinders and masonry wells are essentially the same.

Where the river bed consists of layers of sand and rough gravel mixed, with or without a certain amount of smaller and larger stones interspersed, it will be found cheapest and quickest to make an open excavation without lining or shoeing of any kind except in the pump-well. This can be done by giving the sides a slope of one half or three-quarters to one. The excavated material can be taken out either with a crane or with wheel-barrows, and should be placed in such a position as to offer additional security against any breakage in dams, floods caused by heavy rains, or other natural agencies.

The pump-well should be made in one corner of the excavation, and for a pump of from five to ten inches bore a well with an area of twenty to twenty-five feet is required. This can be sunk advantageously by placing planks about six feet long on end and outside of two wooden frames, one about a foot from the bottom end and the other close to the top.

As the excavation inside this lining proceeds, the suction tube should be lowered, and whenever the lower end of a plank has been left free by picking out the obstructing material, it should at once be driven down as far as possible. By giving the part of the well above the lining a slope of about one-half to only one length of planks will be required, and this method will be found cheaper and more convenient than lining the well through the whole depth. The well should be continually at least two feet lower than the excavation, so that this may be the better drained.

Many engineers, when not directly interested in the cost of the work, disapprove of the idea of making an open excavation in water-bearing ground without lining, and generally suggest some more complicated method. It is true that the open excavation requires of the constructing engineer his personal supervision of details, which means hard work; but it is also true that, when at all practicable, this is by far the cheapest way of doing the work.

Under circumstances as those described, it is customary to place the brick or stone masonry on a concrete foundation of from one to two feet in thickness, and with an offset of nine or twelve inches on all sides. When, therefore, the excavation is down to the proper depth and the bottom has been made as nearly as possible the exact size of the concrete foundation, the latter can be made very satisfactory by letting concrete, mixed in the ordinary way, down a chute to the bottom of the excavation. To prevent the inflowing water from washing the cement of the concrete into the pump-well, the water should be allowed to rise to a convenient height so as to become calm with no applicable current towards the well. When good Portland cement or its equivalent is used, and the earth acts as a casing, it will be quite safe to commence building on the top of the concrete foundation twelve to eighteen hours after it has been made.

Before any masonry is started the work should be carefully marked off. If the pier has a base with one or more offsets, as is usually the case, no great accuracy is necessary until the level of neat work is reached; but if at any stage of the work below ground-level it is necessary to mark off the work, this should be done in accordance with some *one* convenient method. I have found the following process simple, rapid and reliable: A thin wire is stretched between two center line points, across the excavation; and with a plummet this line is projected on the work below. The center of the pier is found by measuring along the center line the required distance from the nearest fixed points. This measurement can be accurately made with a steel tape held as nearly level as possible, on which the distance is read off and projected on the center line in the usual way. The pier can now be marked off with an ordinary wooden square and a straight edge.

Another way of marking the cross center-lines of the piers is to place stakes on both sides of the excavations and at right angles to the center line of the bridge, before work is commenced. But as these stakes are much exposed and likely to be disturbed during the progress of the work, they should be used only for marking off excavations, foundations, and such work as does not require any great accuracy.

A good centrifugal pump is very efficacious for drawing the water from the wells and excavations. As it occupies little space, is simple to erect, easy to move, and seldom gets out of order, it is more suitable for this kind of work than any other form of pump.

An easy-working, sliding suction and a simple, effective foot-valve are essential to a successful and economical management of the work. The sliding suction usually consists of a pipe or cylinder having a stuffing-box at one end and a flange for the foot-valve at the other. It is preferably made of sheet-iron, so as not to be unnecessarily heavy. Inside this cylinder is placed a pipe of the same bore as the pump. The gland of the stuffing-box should run easily on the pipe, so that the cylinder may be moved freely up and down when the gland is loosened. A good foot-valve is made of an ordinary valve-chamber with an iron flap on hinges, moving freely, and with a leather edge to make a water-tight joint with the valve-seat.

It is very important that close and constant attention be given to the pumping machinery, as any interruption in the discharge of the water will cause it to rise in the excavation, and when it is afterwards pumped out it is likely to wash down the material of the sides and entail considerable loss.

These remarks have been written with reference mainly to work on new railways. Other conditions will often suggest changes to be made in the methods of working, of obvious advantage.

SPECIFICATIONS FOR BRICK PAVING IN CLEVELAND.

BRICK pavements are being laid in Cleveland under the following specifications:

"Upon the sub-grade shall be placed a bed of ballast of bank sand or gravel of a quality to be approved by the engineer to a depth of not less than eight inches under the bottom of the brick, except where the material in place is suitable for ballast, in which case such less amount shall be added to the acceptable material as he may direct. The ballast, after being properly rolled and brought to the proper crown, shall be made hard and compact by rolling and tamping in such a manner and extent as the engineer shall direct, the roller to be not less than three feet in diameter, or more than six feet on the face, and shall be loaded to weigh six or eight tons, as required. All places that have not been or can not be properly rolled shall be tamped with small hand-tampers of not more than twelve inches square face, and not less than 90 pounds weight. The rolling and the tamping of the foundation shall always be kept at a distance of not less than 100 feet ahead of the pavement unless otherwise permitted by the engineer. The foundation thus prepared shall be brought to a proper crown by the use of a scraper of such design and curvature as the engineer shall direct.

"Paving brick shall consist of the best quality of sound, hard-burned fire-clay paving brick, made and burned specially for street paving purposes, and shall stand all reasonable tests as to durability and fitness required by the engineer, and to which paving material is usually subjected; the material to be burned in down-draft kilns or furnaces. All brick are to be square-edged and straight, free from cracks and other defects, and of uniform size and color, of not less than 2½ in. x 4½ in. x 8 in., and of a quality

to be approved of by the engineer, and equal to the approved samples of Porter's Union brand of paving brick. The brick to be made with slight projections upon the sides for the purpose of keeping them apart when laid—or made with plain sides and laid in connection with wood strips as the engineer may direct.

"Upon the ballast or earth foundation the paving brick are to be laid in the following manner: The pavement is to be constructed with a single layer of brick laid on edge, end to end, in right angles across the street, as the engineer shall direct, except at street intersections, where the courses are to be placed at such angles as he shall designate. The brick are to be set in straight courses, with the body of the brick about one eighth of an inch apart, but touching each other on ends of brick, and breaking joints at least three inches with the brick in the adjoining courses; they are to be set perpendicular to the grade of the street, and to a height of from one-half to one inch, or to such other height as the engineer may direct, above the true grade and crown of the street when finished, and to provide for settlement in pounding and rolling. After the brick are laid, the end-points are to be made close and compact by use of an iron bar applied to the ends next the curb. Every fourth course, or as the engineer shall direct, the brick are to be closed up and the courses straightened by the use of a sledge-hammer and wood-bar placed against the brick. Nothing but whole brick shall be used, except in starting a course or making a closure at curbs, catch-basins, car-tracks, or other street structures, where not less than half brick may be used in breaking joints, which shall be made tight and close at ends. Great care shall be taken in breaking and trimming the brick for this purpose, so as not to check or fracture the part to be used; all joints to be broken or cut at right angles to top and sides of the brick; the breaking and trimming must be done by experienced men working with proper tools made for this purpose.

"The courses of brick are to be kept the specified one-eighth-inch apart to receive the cement filling, by slight projections made upon the brick for that purpose, if, in the opinion of the engineer, good and proper material can be readily secured; otherwise, at his option, plain brick of the quality specified, may be used with ½x2-inch wood strips placed between the rows. The paving, when laid as specified, to be thoroughly rammed in courses three separate times, as may be directed, besides the final or surface ramming, using a square rammer, weighing not less than ninety pounds, no iron of any kind being allowed on its lower face to come in contact with the paving. In the fourth or final ramming the pavement to be surfaced up by using a long straight-edge, and, when complete, to conform to the true grade and crown of the roadway as directed by the engineer.

"The joints or spaces between the brick to the full depth of the same shall be filled with a concrete composition of not less than ten per cent. of refined Trinidad asphalt, mixed with coal tar cement, distilled at a temperature of not less than 600 degrees Fahr., and the whole mixed with such proper proportion of still-wax as not to soften or become brittle under heat or cold. The composition shall be heated and poured into the joints or spaces at a temperature of not less than 300 degrees Fahr., to be determined by a proper gauge or indicator placed upon the tank used in the street; extra material and care shall be used at the gutters in filling all joints in both paving and curbing and around catch basins or other receptacles to effectually prevent the leakage of water into the subroadway; all joints to be completely filled to the top, and refilled such number of times thereafter as may be directed before adding top-dressing. The concrete not to be used until the brick are completely dry. No flooding of the concrete on top of the brick for the purpose of filling the joints will be allowed.

"The surface of the paving, when completed, shall be covered with a one-half-inch top-dressing of clean, coarse sand or gravel, of approved quality, which, with all accumulations, shall afterwards be removed at such time before the final acceptance of the work by the board as the engineer shall direct, and the pavement left clean for inspection."

MR. STUDEBAKER'S VIEWS REGARDING THE IMPROVEMENT OF COUNTRY ROADS.

HON. CLEM STUDEBAKER of South Bend, Ind., believes that the improvement of the country roads of the United States should be under the direction of the federal government, and he thinks that the war department should have charge of the work. In a recent letter to the editor of PAVING AND MUNICIPAL ENGINEERING he says on this subject:

"Municipalities in some instances, I have understood, have organized branches constituting labor bureaus. All able-bodied persons applying for aid in these cities are referred to this bureau. Through this bureau such persons are enabled to do some kind of manual labor, like wood sawing, or street cleaning or road making, at a nominal rate of wages, sufficient to give them food and shelter for their earnings. These municipalities have in connection with this idea enacted stringent ordinances against vagrancy, and they find that the lazy, idle classes give their boundaries a wide berth. Let us try this system on a national scale. Nature and invention so reward the efforts of man in this land of ours, that those who are provident and industrious, easily make much more than a living. Those who are specially gifted in business qualities acquire colossal fortunes. But still we have the poor. Still we have the homeless. Still we have the hungry. Still we have the unemployed. Why can not the general government, by a simple plan such as I have proposed, give work to every unemployed laborer, of course at wages which offer no temptation to the ambitious or the intelligent to contentedly continue at this work, but if nothing more favorable offered, here would always be an opportunity to earn honest bread. I do not need to enlarge upon the enormous advantages of such a state of things from a humanitarian or philanthropic point of view. The moral effect of such a state of things, precluding every excuse that the lazy or vicious might offer to condone their circumstances, would, it seems to me, be enormous and really incalculable.

"Now, as to the work of road-building itself: I think the true place to lodge supervision over this work is with the national government, and as I have stated, it seems to me that the War Department is the branch of the service peculiarly adapted to give intelligent and efficient oversight to internal improvement of this nature. You will understand that I have not undertaken the elaboration of this idea. I can easily see that it would not be expedient for the general government to assume the whole cost of country road-building. Every section of the country would feel that its interests ought to be attended to first, and the government would be besieged from every quarter with appeals for such improvements. Let the government, however, undertake supervision of the work and the elaboration of all plans and specifications for roadways, bridges, culverts, and the like, and the oversight and direction of all labor employed, with the assumption of one-half, or some other per cent., of the total cost, the remainder to be paid by the state, county, and perhaps a certain amount of special assessment against those whose property seems to be most directly benefited by the road-making.

"Believing, as I do, that this work should be in charge of the general government, it seems to me that we should first bend our energies to securing the adoption of a national policy favorable to these internal improvements. When this is done then let us move up promptly with state co-operation. I think this plan is comprehensive, harmonious, practical, and if properly and urgently brought to the attention of the people, could not fail to create a sentiment of most hearty approval. * * * In the furtherance of these objects, I can assure you that my hearty support and co-operation may confidently be relied on."

A COMMITTEE'S VIEWS ON PAVING.

A REPORT from the Committee on Pavements and Street Cleaning to the Municipal Improvement Association, at a recent meeting in Kansas City, contained the following:

"Your committee has received reports from twenty-six cities, all recommending some form of stone block for the business streets. The city of Liverpool, the best paved commercial city in the world, has this kind of pavement. The streets are divided into classes, all being paved with stone block, the difference being in the foundation. The first class have a foundation of hydraulic concrete, from six to twelve inches; the second class, six inches of bituminous concrete, made of clean, angular, broken stone, grouted with a hot mixture of coal pitch and creosote oil, covered with chippings and thoroughly consolidated by rolling; the third class have foundations of hard placed rock, ten inches deep, set on edge, and over this enough gravel to fill the spaces and form a smooth surface. This is then compacted with a steam-roller. The durability of stone block pavement is acknowledged by all paving experts to be much greater than that of any other kind. Many

streets in Paris and Brussels have been paved with porphyry, and, though subjected to heavy traffic, show no wear. Under first-class specifications, 3 x 6 inch blocks cost $3.37 per square yard; second-class, four inch, or 3 x 5, on four inch concrete, $2.59; third class $2. The cost of their maintenance in Liverpool was $37,000 last year.

"In Kansas City three kinds of paving are used—sandstone from Colorado, granite from Sioux City and from this state. The cost of each kind laid is from $2 to $2.50 per yard. The average life of stone block here is supposed to be from twenty to twenty-three years. The average life of granite in the United States and England is from twenty to forty years. The cleansing of stone block averages about the same as those paved with wood and asphalt. The great objection to stone block is the noise of vehicles passing over it."

The advantages of the various paving materials are then enumerated. Regarding asphalt the report has this to say:

"It produces no dust, and therefore no mud; it is comparatively noiseless; it does not absorb and retain organic matter; it is impermeable to moisture, and neither emits nor allows the emission from the subsoil of unwholesome and poisonous vapors. The comparative merits of stone and asphalt are: Stone possesses the longest life; asphalt is cheaper; asphalt is more easily cleaned and is the most pleasing, smooth and clean. The advantages of properly laid asphalt are: durability, smoothness, maintenance, noiselessness, economy, and popularity. The objections are: cost of construction, slipperiness in wet or frosty weather; short life of pavement; water is its greatest foe, as the residuum is absorbed when constantly exposed to water, destroying the binding qualities, when disintegration sets in."

On the subject of brick the report says:

"The advantages claimed for brick are that it is cheap, durable and comfortable, being free from dust and comparatively noiseless, healthful, because vitrified brick are non-absorbent, so do not emit unhealthful odors; safe, because horses do not slip upon them; economical, because they are easily repaired and are cheaply and easily cleaned. Of thirty kinds of brick tested at Omaha recently, brick from Kansas City was awarded first place."

On the subject of macadam the report says:

"It would be well to lay down two general propositions: No rock is uniform for a great number of miles; and consequently bad material may be derived from a rock of generally good reputation; no rock, that is, limestone, at Kansas City is so poor that none of it is adapted to macadam material; consequently no rock should be condemned in toto. The great safeguards to the property-holder and to the public are the specifications of paving contracts. The contract should specify the kind of rock for lower and upper layer of macadam. Under certain restrictions, the contractor might be allowed to make substitutions, if in the judgment of the city engineer they are equal to the rocks specified.

"Macadam should be laid in two layers and no more; the lower layer should be of pieces ranging in size from two to six inches in their greatest diameters, broken into cubes as nearly as possible. The upper layer should be broken into pieces from one and a half inches to three and a half inches in their greatest diameters; sand, sandy loam or cinders make a good dressing to bed the limestone, but the bedding should be worked down into the interstices of the macadam. At least the lower layer should be broken by hand on the ground; the lower layer should not be rolled enough to smooth the surface, and thus allow the top layer to vibrate and grind against it at the line of contact; the sub grade and the top layer should be thoroughly rolled; the contractor should be required by the contract to keep the macadam in repair for a year; no macadam of a less thickness than twelve inches should be laid in the streets where there will be much heavy traffic. The cost of original macadam well laid ranges from sixty-five to eighty-five cents per square yard; brick, $1.65 to $1.80; asphalt, $2.00 to $2.80; stone block, $2.00 to $2.50. The advantages of macadam are in cost, noiselessness and ease of repair. The objections are liability to ruts, disintegration of surface. In order to make macadam a success, it is very important that each and every street within a certain radius be paved."

PAVING BRICK IN THE EAST.

MR. CHARLES H. BLACK, superintendent of streets of Chelsea, Mass., in his annual report, just issued, says: "The study of clays for pavement brick-making has received much attention during the last few years, owing to the rapidly-increasing popularity of this material for streets and roadways. While many clays will make a good brick, if properly burned, the shale clay has proved the most serviceable. The brick made at the Purington yard at Galesburg, Ill., where the shale clay was first discovered to be useful for this purpose, the first pavement brick being made there seven years ago; since which time a number of brick-yards have been established in different parts of the country where the clay has been found. It is named vitrified paving brick, and has attained a remarkable popularity, as a street and road pavement, during the last seven years, there being about two hundred and fifty miles of it used in the various cities of the United States at the present time. As the material is not subject to rot or decay, it is easily kept clean, and the bricks fit so close together there are no interspaces to retain filth and breed disease. Being laid in a body of sand, which forms a cushion upon which the bricks rest, it is almost noiseless. Bricks do not polish under the wear, and always afford a good foothold to horses. I most respectfully recommend that a small amount of brick pavement be laid the coming year as an experiment."

PAVING PLANS IN NEW YORK CITY.

IN 1866 most of the streets were paved with cobble-stones, full of ruts and hollows, and imperfectly cleaned. The main thoroughfares have since been repaved chiefly with Belgian blocks, and, within a very short time, many miles of granite blocks have been put down in Broadway and other streets. After numerous experiments this has been given the preference in view of the heavy traffic in New York streets. It is about decided that New York is to spend $1,500,000 a year, for two years, in the repaving of streets—a sum which, in addition to the $3,000,000 lately invested in similar improvements, will make it one of the best paved cities in the world.—*Charles F. Wiggins, in Engineering Magazine, June.*

A BOULEVARD BETWEEN BALTIMORE AND WASHINGTON.

FOR the past seven years it has been the dream of certain men in Maryland to connect Baltimore and Washington by a grand avenue paved and fitted out with some form of rapid transit. The street has been spoken of as a continuous park between the two cities, with driveways for heavy and light traffic, the whole to be flanked by country residences and suburban towns.

Naturally the enterprise will cost much money, and its realization would have to be a gradual development from each end toward the middle. Its success will depend upon the efficiency of its rapid transit system, and the advantages offered to home buyers along the route. Managed properly by far-sighted men, who could withstand the greed of the ordinary real estate dealer, the scheme might be worked out, otherwise it would fail. A Columbian boulevard, organized and carried out on the notion of fleecing tenants for ground rent and selling village lots in a Prince George's swamp would fail, as it ought to fail.

A bill was introduced in the last legislature incorporating a company to undertake the building of this boulevard. It is also understood that operations are soon to begin with a view to making a continuous metropolitan street between the two cities. The enterprise will not be completed for several years, if it ever is, but its progress will be watched with a good degree of interest here and elsewhere.—*Baltimore Herald.*

A WATER PAVEMENT.

AN EXPERIMENT is being tried on Front street at Palatka, Fla., which is called a water pavement. The inventor conceived the idea from the hardness of the seashore and the principle lies in keeping the earth constantly moist so that traffic thereby makes it the more compact. The street was first leveled and a long, perforated pipe was laid down the center, the street graded from the center down the sides; the pipe then connected with an artesian well and the water running through the pipe saturates the entire street. The experiment is watched with great interest and it is said the street is beginning to harden already.

PAPERS ON ENGINEERING SUBJECTS.

THE engineering societies of the University of Illinois have issued the sixth annual edition of "The Technograph," which contains well condensed articles from the papers on various technical subjects read before the societies during the last year. The writers who are represented in the publication are, Gen. William Sooy Smith, Z. Foster, P. Mogensen, R. J. Dickinson, H. Dunaway, C. J. Butterfield, B. V. Swenson, S. Shiga, F. M. Spalding, Prof. A. N. Talbott, Prof. Ira O. Baker, R. A. Mather, E. S. Keene, William C. Klingelhoefer, F. W. Clark, H. M. Lyman, J. M. White, and others. The number contains many good illustrations and is, both in typography and matter, creditable to the university.

Improvement and Contracting News.

PAVING.

Four streets will be improved at Kokomo, Ind.

Monroe, Mich., will spend $25,000 in paving.

The streets of Globeville, Col., are to be improved.

The Owosso (Mich.) council is still discussing paving.

Bellevue, Ohio, is planning to pave two more of her streets.

Four thousand feet of concrete walks will be laid at Tipton, Iowa.

Fremont, Neb., will experiment with a section of brick paving.

The city of Oskaloosa, Iowa, has decided to go ahead with paving.

Ridgewood, N. Y., has voted $30,000 for macadamizing the streets.

The streets of Kalamazoo, Mich., are to be paved with cedar blocks.

Monmouth, Ill., has let the contract for about $57,000 worth of street paving.

Resolutions have been adopted for paving fifteen streets at Burlington, Iowa.

At Toledo, Ohio, Bancroft street from La Grange to Erie street will be paved.

Linn street, Cincinnati, O., is to be paved with brick at an estimated cost of $75,221.

Faribault, Minn., is talking of paving Main street and putting in a sewerage system.

Mendota, Ill., is working vigorously for street paving and a good sewerage system.

Boone, Iowa, has petitioned the council to pave two of the principal streets of that burg.

Two streets are to be paved with brick at Youngstown, Ohio, one at a cost of $25,000.

A vitrified brick pavement is being laid on Main street, Dubuque, Iowa, by Atkins & Oloff.

The work of paving Russell avenue at Cleveland, Ohio, with brick, has been commenced.

About 2,000 square yards of brick street paving will be laid on Center street, Meyersdale, Pa.

The council of Sioux Falls, S. D., has passed resolutions to pave nine streets with stone blocks.

First street, Evansville, Ind., is to be improved with brick and work has commenced on same.

The road committee of Bloomfield, N. J. has prepared plans for macadamizing to cost about $18,000.

Carroll & Landis were awarded the contract for $10,948 square yards of brick paving at Salem, Ohio.

Pine street, between Front and First streets, at Portland, Ore., is being paved with bituminous rock.

Four hundred thousand dollars worth of paving has been ordered by the council of Salt Lake City, Utah.

The selectmen of Birmingham, Ct., have settled on an appropriation of $1,000 to pave a portion of Derby avenue.

Work has begun on the laying of asphalt pavements at Augusta, Ga., and the same will be pushed rapidly to completion.

The boulevard as now planned along the Schuylkill at Reading, Pa., is four and a half miles long, and will cost $50,000.

Carlinville, Ill., has appropriated $40,000 for improvements, $8,000 of which will be used for paving, and $5,000 for sewers.

The board of streets at Newark, N. J., has voted to pave twelve streets, including four with asphalt and six with granite blocks.

Districts 415, 416 and 419, Omaha, Neb., will be curbed with red Colorado sandstone by J. W. Furnas & Son, at 59 cents per lineal foot.

At Orange, N. J., John O'Rourke will curb and macadamize South Walnut street, and Patrick McCann will place flagging on Glenwood avenue.

Contracts for five miles of street grading at Seattle, Wash., have recently been let. The bids are for the removal of 60,000 cubic yards of earth.

The common council of Auburn, N. Y., voted only $8,000 for paving streets during this year; half the amount that has heretofore been appropriated.

The city of Norristown, Pa., will increase its indebtedness about $40,000 for the purpose of paving six squares of the two main streets with asphalt.

The street and sewer department of Wilmington, Del., will spend $100,000 on city streets this year. It has awarded a contract for 3,000,000 vitrified brick.

Some of the progressive and enterprising citizens of Cadillac, Mich., are thoughtfully considering a proposition to improve the business and residence streets of that place.

At least one main street will be paved with fire brick at Ashtabula, Ohio, this year. The council passed the first ordinance for street paving in that city last month.

The city of Syracuse, N. Y., has contracted with J. M. Mack & Co., for paving South West street with vitrified brick from the New York Central tracks to West Onondaga street.

Wylie avenue, Pittsburgh, Pa., is being repaired and will soon be one of the best paved streets in that city. A block stone pavement will reach from Fifth avenue to Herron Hill.

An ordinance was recommended authorizing the regrading and repaving of Federal street from North Diamond street to North avenue with Belgian block at Allegheny, Pa.

It is understood that an order is being prepared for the city government of Taunton, Mass., to endorse authorizing the loan of $20,000 for paving operations in various sections of that city.

Grand River avenue, at Detroit, Mich., is to be paved with brick. The Talbot Paving Company was the lowest bidders on both sections, and their bids were for $54,-112.84 and $52,033.82.

At Philadelphia, Pa., there are twenty-eight streets to be repaved with granite blocks, three with sheet asphaltum and twenty two with vitrified brick. Over 100 streets are to be regraded.

City Civil Engineer Kinnear's report shows that during the past year $1,377,-909.37 to be the total cost of all improvements at Columbus, O. The city has 77.39 miles of improved streets.

Within two years $5,000,000 is to be spent in improving the west side park system at Chicago, Ill. Within twelve months, or by May, 1893, the larger part of this outlay will have been made.

At Chester, N. J., the contract for about 12 miles of road has been awarded B. & J. F. Shanley, at 93 cents per square yard for telford and 79 cents and 67 cents for 8 inch and 6 inch macadam respectively.

Main street, between Bridge and Cutler at Helena, Mont., is being paved with wooden blocks on a foundation of broken stone which has been rolled and over which has been laid a layer of sand.

Sewickley, Pa., intends to spend considerable money this summer on borough improvements. When through the streets will be better, the water supply improved, and the town likely sewered throughout.

The boulevard system of St. Louis, Mo., is not yet complete. There are now several boulevards in the western part of the city running east, west, north and south, but it is desired to belt the city with boulevards.

Sealed proposals will be received by the board of public affairs of the city of Springfield, O, until June 27, for construction of street crossings, sidewalks, curb and gutters, grading and graveling, and paving gutters.

The council of Ashland, Wis., has decided to do some extensive street paving this summer. It has been decided to issue $75,000 worth of improvement bonds, and about five miles of streets will be paved by next winter.

The estimated cost of paving Eighth street from Howard street to Michigan avenue, and High street from Fourth street to Trumbull avenue, with cedar blocks and plank, at Detroit, Mich., is $9,400 and $7,-500 respectively.

The common council of Bay City, Mich., passed a resolution for repaving Center avenue. The resolution provides that the street shall be paved with brick, from Water to Jefferson streets, and thence east with cedar blocks.

The board of public works of Racine, Wis., have concluded to recommend that the alleys in blocks 12 and 13 be paved with brick. If it proves satisfactory it may be the means of having streets paved with the same material.

The council of Memphis, Tenn., has ordered three important pieces of work to be done this season: the paving of Union street from Main to Front, South Court street, and the east side of Main, from Auction street to the bayou.

Carll street, Cincinnati, Ohio, from Western avenue to three hundred feet west of Linden street, is to be improved by grading, curb setting and paving with brick; also by constructing the necessary culverts, drains and retaining walls.

Seven hundred thousand dollars will be spent, in laying improved pavements in various streets at Philadelphia, Pa., before cold weather. The specifications call for asphaltum, broken stone, vitrified brick and Pennsylvania and Lambertville blocks.

The city of Raleigh, N. C., will do a good deal of additional paving this year. Only Belgian blocks are use, and the total cost of a square yard of pavement, complete, is $1.50, and one-third of the cost is paid for by property owners on each side of the street.

A company has been organized in Crawford county, Ind., to build a turnpike from Leavenworth, the county seat, to Marengo. The name of the corporation is the Leavenworth, Pilot Knob and Marengo Turnpike Company, and the capital stock is $50,000.

When the present contracts for street work at Chattanooga, Tenn., are paid for, the board of public works will have $46,798.26. This fund will be used to pave East Sixth street from Market to Lookout streets, and Hooke street from Boyce to Cowart streets.

Kiever & Burke were awarded the contract for grading North Nineteenth street between Tower and Hammond streets, at Superior, Wis., at a bid of $1,844.87, and W. G. Rhodes was given the contract for grading North Twentieth street between the South Shore track and Hammond street at a bid of $3,249.14.

Three miles of new asphalt paving are to be laid in Troy, N. Y. The streets to be paved are Eighth, between Fulton and Hoosic, 2,893 feet; Second, between Adams and Main streets, 5,600; Third, from Adams street to the junction of Third and Fourth streets, 3,200 feet; Sixth avenue, between Rensselaer street and the city line, 3,920.

By request, City Engineer Graves has drawn a plan for the improvement of Washington street at Alexandria, Va. The plat presents the street with two roadways, and in the center a lawn and shade trees. The street is seventeen squares long, and a pavement laid thereon will be the beginning of a general movement in the direction of better streets.

This season promises to be a very busy one at Fond du Lac, Wis., in the matter of public improvements. Petitions are being considered for pavements on Harney, Fourth and Second streets, and for sewers on Eighth, Fourth, Second and Sheboygan streets. Eighth street will be the main thoroughfare leading to the kite-track park and will be macadamized.

South High street, Columbus, O., is to be converted into a handsome driveway. N. B. Abbott & Co. received the contract for paving it with a Hallwood block pavement from Hanford street to the south corporation line. The pavement is to have tar filling and screened gravel foundation, and the residents propose to have shade trees planted along the thoroughfare and the improvements necessary for a fine driveway.

The board of public works of Kansas City, Mo., has authorized the grading, curbing and paving of several streets. Among them is the curbing and laying sidewalks on both sides of Tracy avenue from Eighteenth to Nineteenth streets; macadamizing the alley between Campbell and Harrison streets, from Seventeenth to Eighteenth streets, and paving Eighth street from Penn to Jefferson streets, with asphalt.

The trustees of Portchester, N. Y., will call a meeting this month to have the taxpayers vote on the raising of $4,000 extra for repairs of the roads, making the fund $10,000, and $1,000 for street lights in the newly acquired territory to the village.

A new county road is being advocated between Plainfield and Rahway, N. J. The proposed road is to start from Prospect avenue at Short Hills, intersect Short Hill road and connect with the county road at North Rahway. It will be macadamized.

Bids will be received at the auditor's office at Athens county, Ohio, till Monday, June 27, for grading, excavation, foundation, limestone, graveling, etc., of roads along the following routes, viz.: Greenbranch extension, Guysville road, Carthage township; Coolville and Pomeroy road, Troy township; Nelsonville Cemetery road, York township; Amesville and Athers (Amesville) road, Ames township; Trimble and Glouster road, Trimble township.

The city council of Rockford, Ill., has passed the necessary ordinance for the improving of Harlem avenue. It is 106 feet wide, and one mile long, and leads to a beautiful park. The improvements will consist of curbing both sides 20 feet from property line with 4 by 24 limestone, and for macadamizing two driveways, each 22 feet from curbstones with Rockford stone foundation, and imported crushed stone for top dressing, with cobblestone inside borders, and through the center, which will be 22 feet wide, will run an electric street railway with grass and trees on either side.

SEWERS.

A sewer system is to be constructed in West Concord, N. H.

Several 12 to 18-inch pipe sewers are to be constructed at Paterson, N. J.

Sioux Falls, S. D., is taking steps to have a scientific system of sewers.

A system of sewerage is to be constructed at Beaumont, Texas, this season.

During the season the sewer system will be greatly extended at Fond du Lac, Wis.

The council of Chicago, Ill., has passed ordinances for main sewers to cost $250,000.

Work is being energetically pushed on sewer construction in Freeport and Aurora, Ill.

The city treasurer of Lynn, Mass., has been authorized to issue sewer bonds for $20,000.

Pipe sewers to cost about $12,000 has been ordered for Worcester, Mass., by the council.

A system of sewerage is being agitated for Geneva, N. Y.; estimated cost, $80,000 to $100,000.

A main sewer will be constructed at Great Falls, Mont., this summer to cost about $35,000.

It has been voted at Deadwood, S. D., to bond the city for $40,000 for a complete system of sewerage.

Plans for a drainage system to cost $16,500 have been accepted for Puyallup, Wash. Bonds will be issued.

Alsip & Co. have secured the contract for seven miles of new sewers to be put in this year at Grand Forks, Minn.

The citizens of Tarrytown, N. Y., voted to bond the village for $10,000 to complete the system of sewerage at that place.

The contract for building a sewerage system for Creston, Ia., has been let to J. M. Barris & Co. of Council Bluffs, Ia.

The board of public works, of Denver, Col., recommended the award of the West Denver sewer to O'Rourke, at $66,373.00.

Cortland, N. Y., is moving in the matter of sewers, and it is estimated $40,000 should be immediately expended for that purpose.

The city engineer of York, Pa., has been authorized to employ a sanitary engineer to prepare plans for a system of sewerage.

Civil Engineer Albert Smith has been employed to superintend the laying of a system of sewerage at Monongahela City, Pa.

The sewerage system is progressing rapidly at New Whatcom, Wash. About $12,000 a month is being expended on the work.

An ordinance is before the council of Philadelphia, Pa., authorizing a loan of $250,000 for a main sewer in Pasayunk avenue.

The city of Mobile, Ala., has engaged S. M. Gray, Providence, R. I., to prepare plans and estimates for sewerage and water-works.

The board of sewer commissioners have completed plans and specifications for a system of sewerage to be constructed at Gouverneur, N. Y.

Work on the Park street sewer at Alameda, Cal., is going rapidly onward and the more work done the more need for the new sewer is apparent.

The contract for the construction of the Fifteenth street sewer at Harrisburg, Pa., has been awarded to Ward & Stucker at $3.35 per lineal yard of sewer.

The proposed drainage plan for the city of Olympia, Wash., has been submitted to the council. Ten miles of sewers is the approximate estimate at a cost of $72,414.

John Jacoby was awarded the contract to construct a sewer on Ninth, Buttonwood, Seventh, Eighth and Taylor streets, at a cost of $9,046.80, at Wilmington, Del.

S. E. Babcock, of Little Falls, N. Y., has prepared plans for a system of sewers for Glenn Falls, N. Y., and the citizens have voted in favor of the proposed sewers. The cost is estimated at $167,665.

Austin, Texas, is to have an extensive system of sewerage. The Austin Sewerage Company, which is doing the work, has executed the company's first mortgage bonds for $250,000 for the purpose.

McGovern & Kitch, of Lancaster, Pa., were awarded the contract for building section 27 of the Metropolitan Sewerage System in Somerville and Cambridge, Mass. The amount of their bid was $55,000.

At Racine, Wis., the board of public works has let contracts for about six miles of sewers at a cost of $18,700. More contracts will be let soon, and the greater part of the city will be completed before the end of the year.

At Des Moines, Iowa, Joseph Kehoe will build sewers in two streets: West Eighth street and East Walnut street, at $1.69 and $1.52 per lineal foot respectively. Patrick Murphy will also build a sewer on West Sixth street, at $1.33½ per lineal foot.

Sealed proposals will be received at the office of the board of public works, at Roanoke, Va., until June 20, for furnishing all the labor and materials necessary for the construction of the drains and sewers in sections 1, 2, 3, 4 and 5 of that city.

Walter Wood, of Philadelphia, a sewerage expert, has made a proposition to build a system of sewerage at actual cost at Mobile, Ala., charging the city eight per cent. on the bonds, and all the profits to be equally divided between the city and the company.

Phœnix, A. T., will have the most elaborate sewer system in the interior southwest. It is expected it will be ready for operation in six months and will cost $125,000. W. B. Clapp of Los Angeles, Cal., is sanitary engineer for the construction of same.

Bids have been received and contracts let for the construction of sewers in the following-named streets at Milwaukee, Wis.: Linus, Twenty-fifth, Marshall, Lloyd, Luscomb, Corcoran, Potter, Newhall, Belleview, Bartlett, Bradford, Wine, American avenue and Forest Home avenue.

Fort Dodge, Iowa, is to have a sewerage system in the near future. Preliminary plans have been submitted to the committee of the city council and have been approved, and when the final plans for the Market street sewerage is presented, the council will no doubt order the sewerage put in.

The city government of Worcester, Mass., has passed an order for borrowing $80,000 to complete the city sewage purification works at Quinsigamond. An order was also adopted for beginning the work of constructing new purification tanks, so that the whole body of the sewage may be treated.

Pontiac, Ill., is likely to have a most effective sewerage system. The city council has awarded the contract to construct the Mill and Main street system to Messrs. McCabe and Hill. The Walnut street system will be built by M. Tschirge, Jr. They will be paid for by assessments against the property fronting on them.

It has been recommended that the following sewers be built at New Haven, Ct.: Leonard, between Bradley and Summer streets; Norton street, between Goffe street and Whalley avenue; Foote street, between Winter street and Dixwell avenue; Grand avenue, between Ferry and Poplar streets; Ferry street, between Clay street and Grand avenue.

The sewer commissioners of North Hampton, Mass., have instructed engineer Strong to make layouts for sewers in the center, on Bridge, Prospect and State streets, Washington Place and Columbus, Clark, Lawrence, Grant and Kensington avenues the trunk line of Florence, Maple, Center and North Main streets in ward six. It will take some time to get the preliminary work done but the board hopes to get work started before midsummer.

BRIDGES.

A new iron bridge will be built at Caledonia, Marion Co., O.

A bridge is to be built at Jacks Run, a short distance from Bellevue, Pa.

Two iron bridges are to be built across the Shenandoah river at Riverton, Va.

The question of building a new bridge at West Pikeland, Pa., is being discussed.

An $18,000 stone arch bridge is to replace the one recently burned at Blackstone, Pa.

Topeka, Kan., will build a wire suspension bridge over the Kaw river, to cost $62,000.

Wilmington, Del., has been authorized to issue $5,000 bonds to build a bridge over the Brandywine.

Money has been appropriated for the rebuilding of a bridge over the Wapsie river at Riceville, Iowa.

Farmington, Mass., has appropriated $6,000 for a new iron bridge over Sudbury river on Eastern avenue.

The citizens of Martinsburg, N. Y., have voted to build an iron bridge over the creek on Main street in that village.

An iron bridge will be built over Musconetcong creek at Bloomsbury, N. J., by Warren and Huntington companies.

An iron foot-bridge is to be constructed across the Champlain canal at Cohoes, N. Y., by the Hilton Bridge Company of Albany.

A new iron bridge is to be built across the Republican river, at Oxford, Neb., for the accommodation of Furnas and Harlan counties.

The new steel bridge spanning the Little Kanawha, at Parkersburg, W. Va., has been inspected, accepted and opened to traffic.

An iron bridge is to be erected over the western branch of the Conocheague creek, near Rider's mill at Franklin, Pa., at a cost of $2,900.

At a cost of $125,000 it is proposed to construct an iron bridge over the Susquehana river to connect west Harrisburg with West Fairview, Pa.

The City of Gouverneur, N. Y., has appropriated $12,000 for a new bridge, and immediate steps for its construction will be taken by the commissioners.

Two bridges are to be built at Rochester, N. Y.; one at Mortimer street and the other at Andrew street. Chairman of the board of public works will give details.

The court of Gilmer county, W. Va., has appointed a commissioner to receive bids for the construction of a steel highway bridge over Stewart's creek, in that county.

Sealed proposals will be received until June 18th, for labor and material required for the construction of a high truss iron bridge over Honey Creek, near Tippecanoe City, Ohio.

The Cincinnati and Covington Bridge Company is preparing new specifications for its bridge across the Ohio river, to meet the objections raised by the Secretary of War against it.

A bridge is to be built at Harriman, Tenn., across the Emory river. It will consist of two spans; one 100 feet and the other 200 feet long. There will be one abutment and two sets of iron tubes.

The Water Commissioners at Portsmouth, N. H., have awarded to J. T. Langford the contract for laying the water pipe for a high pressure service. The price is to be $47,513 to complete everything that is required to completely pipe the city and it is to be finished before December of this year.

The county commissioners will have plans prepared for the construction of the Kansas avenue bridge at Kansas City, Kan.

A bridge company has been organized at Allegheny City, Pa., to construct a bridge over the Ohio river from Wilkens street to McKee's Rocks. The capital is $5,000 and is known as the Allegheny McKee's Rock Bridge Company.

WATER-WORKS.

Iowa Falls, Ia., will have a water-works plant.

Hillsboro, Ohio, has voted $75,000 for water-works.

Work has begun on the water-works at Stanford, Ky.

New water-works are being put in at Danville, Ind.

The water plant at Temple, Tex., will be extended and improved.

L' Anse, Mich., is to have a gravity system of water-works.

Union, Ia., now contemplates putting in a system of water-works.

Water bonds in the sum of $20,000 have been issued at Liberty, N. Y.

There is to be an improvement in the water system of Jackson, Mich.

A. S. Hart has the contract for building the new water-works at Danvers, Ill.

The council of Regina, N. W. T., has decided to expend $30,000 for water-works.

Preliminary surveys have been made for a water-works system at Whitestone, N. Y.

The question of putting in a system of water-works at Cameron, Tex., is being discussed.

Preparations are being made to build water-works at Atlanta, Mich., including a stand-pipe.

A stock company is being formed for the purpose of supplying Spring Valley, N. Y., with water.

A gravity system of water-works is to be substituted for Chadron, Neb., in place of the pumping station.

It is reported that a 12-inch water-main will be laid to Bethel, Ct., from Mountain Pond, at a cost of about $10,000.

Contract for an extension of the city's water-works system, mains, etc., at Brownwood, Tex., will be let by August 1st.

George Showell secured the contract for constructing four miles of trenches and laying mains for the system of water-works that Brigham City, Utah, has decided to build.

D. H. Scott & Co., of Topeka, Kan., have been granted a franchise and will put in a $50,000 water-works plant at Oklahoma City, Ok.

The water-works company of Muscatine, Iowa, is considering the putting in of a filtering plant and is also talking of erecting a stand-pipe.

East Syracuse, N. Y., has voted to expend $50,000 for water-works. It is proposed to bring water to the village from a supply about one mile south of Jamesville.

The citizens of West Milton, Ohio, voted on the question of expending about $20,000 on a water-works system and the vote carried by over two-thirds majority.

The plans for a water supply at the new fair grounds, Indianapolis, Ind., have been decided upon. It is proposed to erect a large tank that will answer for all purposes.

Contracts have been made for building a complete system of water-works for Lake Charles, La. Water is to be taken from the Calcasien river and the plant will be completed by Sept. 1st.

Mr. Vaugh, of Stamford, N. Y., was awarded the contract for the addition to be made to the water-works at Sherburne, N. Y. The figures for the completed job are a little over $11,300.

A resolution has been adopted by the board of aldermen of Battle Creek, Mich., to set aside $10,000 for the use of the board of public works in providing and increasing a water supply for that place.

Bridgeport, Conn., is to guard against another water famine by the construction of another big dam on Mill river 1,100 feet long. The dam will flood land about 125 acres in extent and will hold about 800,000,000 gallons.

The Tansa water-works for the supply of Bombay, India, were only completed after very great physical difficulties had been overcome. The work involved the construction of a masonry dam two miles long to form a lake of nearly six square miles in area. There are fifty-five miles of ducts, twenty-seven miles of iron mains, four miles of tunnel, and nearly a mile of iron girder bridges.

The bridge crossing the Mississippi at Memphis, Tenn., is built on the cantilever principle and some idea of the immensity of the structure may be gained from the fact that the length of the bridge and approaches from the Arkansas side to the landing on the Tennessee side is three miles and the bridge proper is three-quarters of a mile long. 9,000 tons of steel have been used in its construction, and it has cost about $3,000,000.

STREET LIGHTING.

Electric street lights are desired by the citizens of Fair Haven, Conn.

Bids will be received until July 1st for lighting the streets of Waterbury, Conn.

A committee has been appointed to secure electric lighting for Barnum, Colo.

Yoakum, Tex., is to have a $15,000 electric plant for lighting the streets of that city.

Electric street lighting has been voted in favor of by the citizens of Green Island, N. Y.

Fourteen thousand dollars is the appropriation for street lighting at Jackson, Mich.

The electric light plant at Moscow, Idaho, is to be improved and 700 incandescent and 50 arc lights added.

Martins Ferry, W. Va., has voted $25,000 for an electric light plant, and it is stated that immediate steps will be taken for its erection.

The council of Providence, R. I., has appointed a special committee to consider the advisability of putting in a municipal electric light plant.

A franchise has been granted and an electric light plant to cost $12,000 will be erected at Waitsburg, Wash., to furnish street lighting for the town.

The Citizens' Electric Light Company's plant at Van Wert, O., will be enlarged and improved by Gen. A. V. Rice, of Ottawa, who has purchased the same.

The Pekin Electric Light and Power Company was awarded the contract for lighting the streets of Pekin, Ill., at $77.50 until 3 A. M., or $80 per light for all night lighting.

STREET-CLEANING IN BERLIN.

The streets of Berlin are cleaned during the night, 600 laborers being employed as a rule. The revolving sweepers are city property, but the horses belong to the contractors, who have charge of removing the refuse and are also obliged to maintain suitable dumping places. The sweepings are of some value, contractors oftentimes realizing over $20,000 from them. They are obliged to remove the rubbish as soon as it is swept up, and only in cases of bad weather are the sweepings allowed to stand more than an hour before being carted away. If these regulations are broken, the contractors forfeit a certain amount to the city.

All streets that are regularly cleaned are also regularly sprinkled, usually twice a day, but sometimes more frequently. The city provides 147 watering carts, which the contractors are obliged to keep in good condition. The carts are filled by city laborers.

The three horse-car companies bear a part of the expense of cleaning. They furnished $21,000. The annual cost of cleaning and watering the streets amounts to about $375,000.

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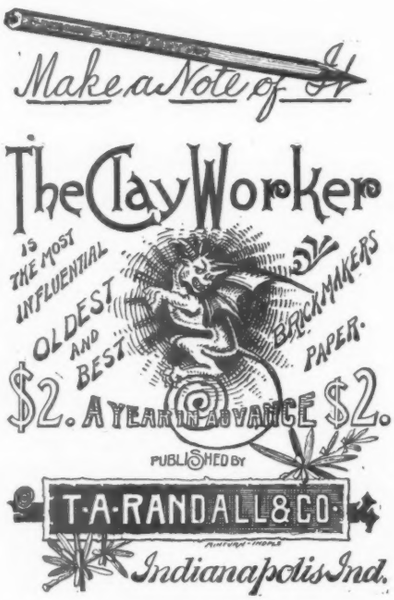

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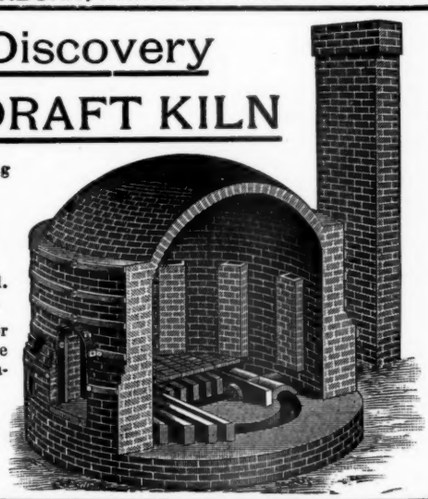

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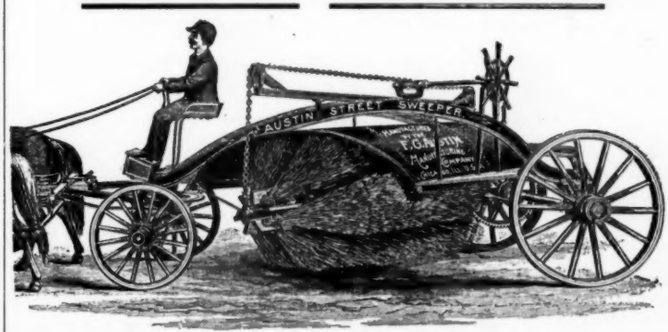

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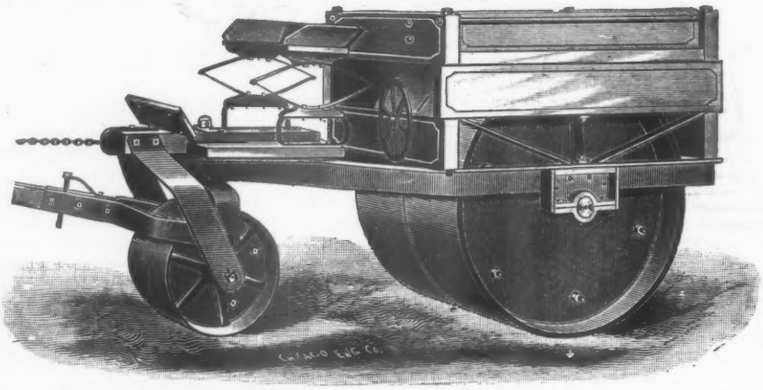

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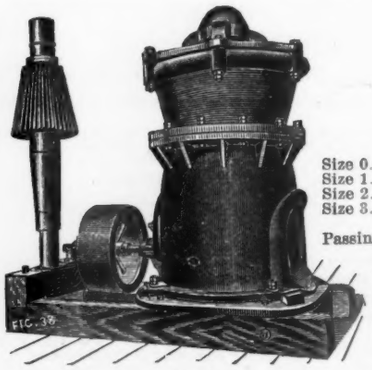

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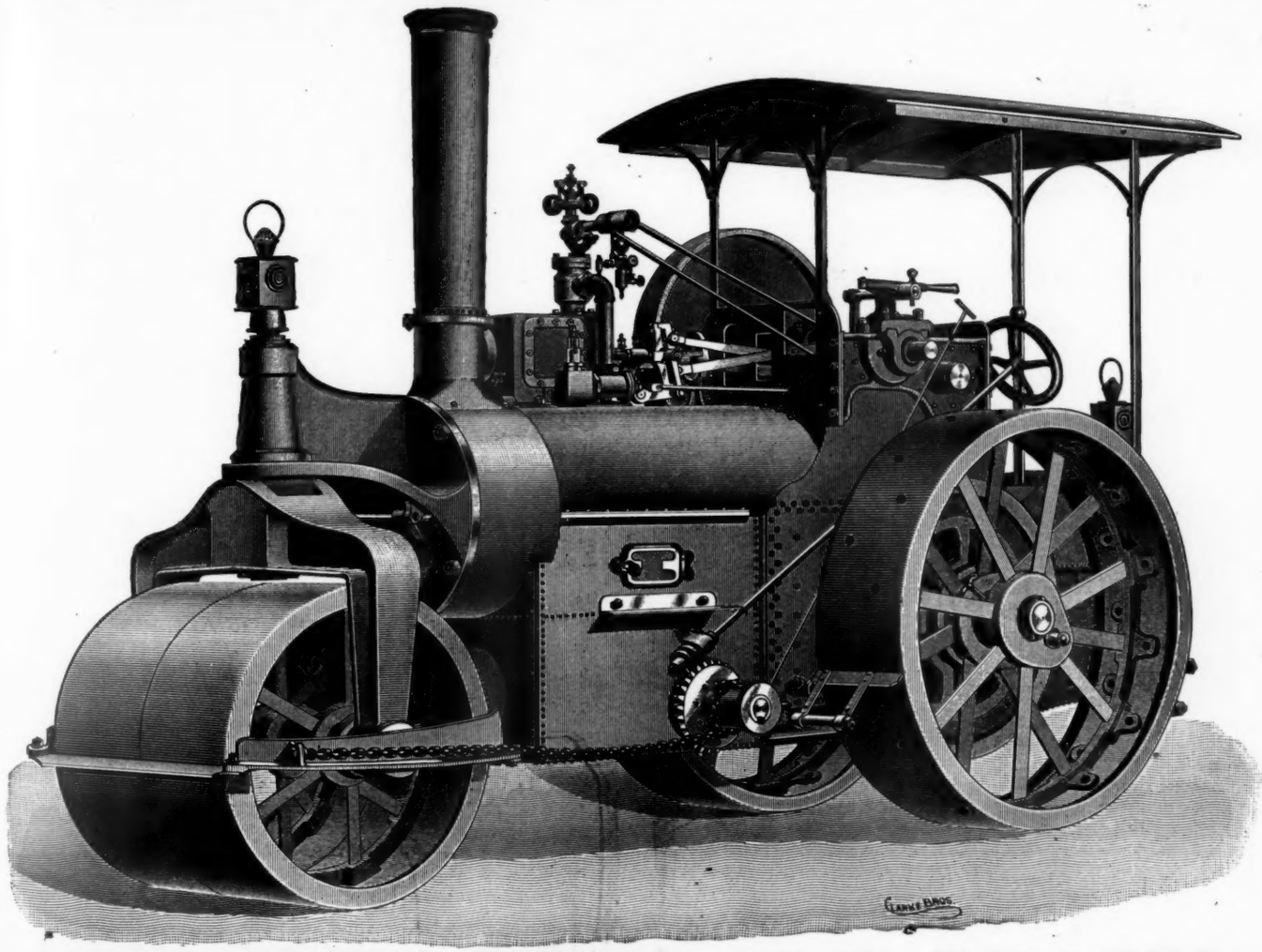

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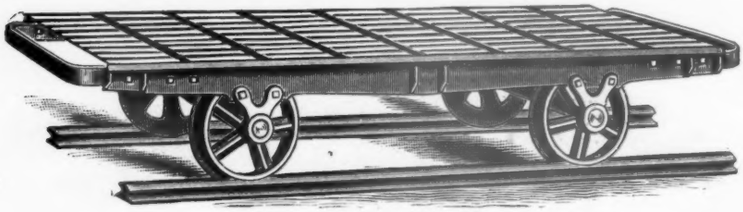

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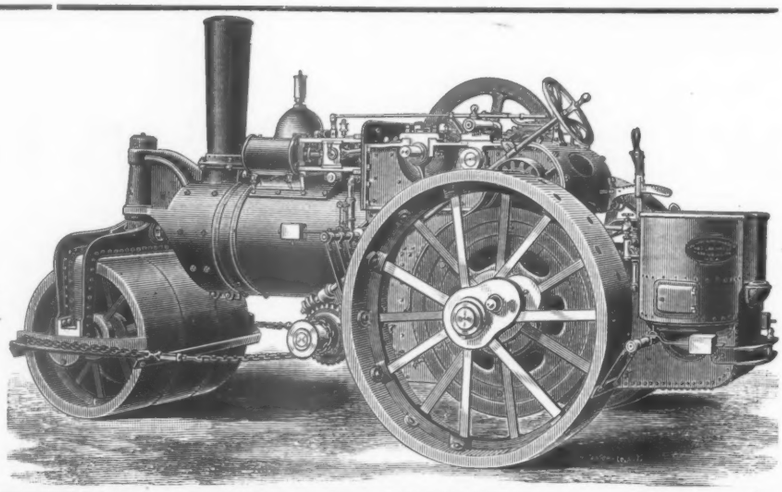

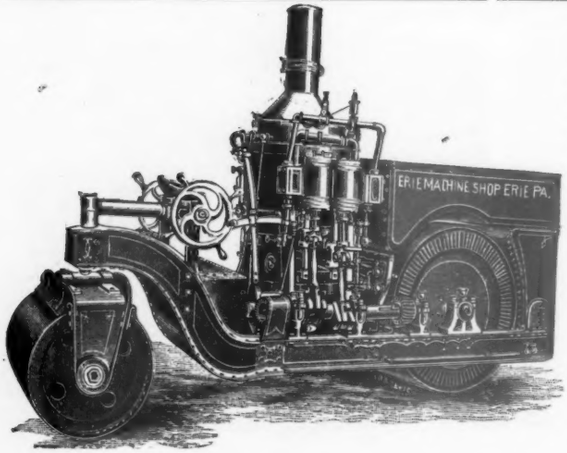

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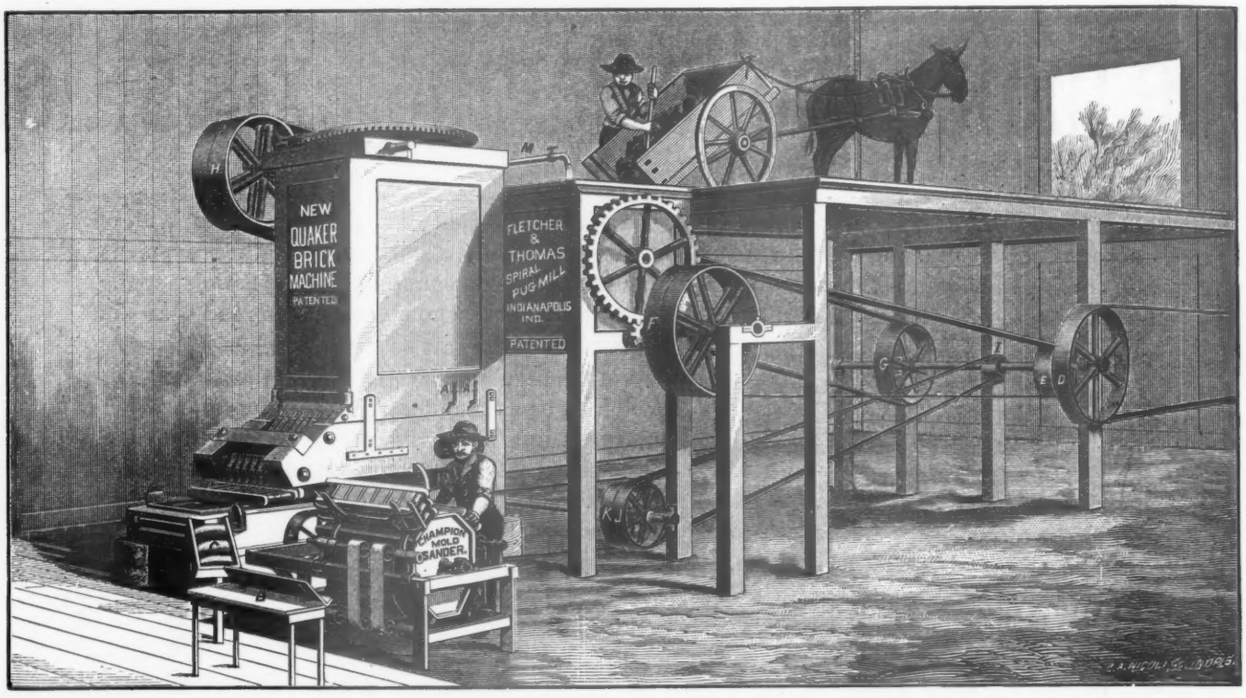

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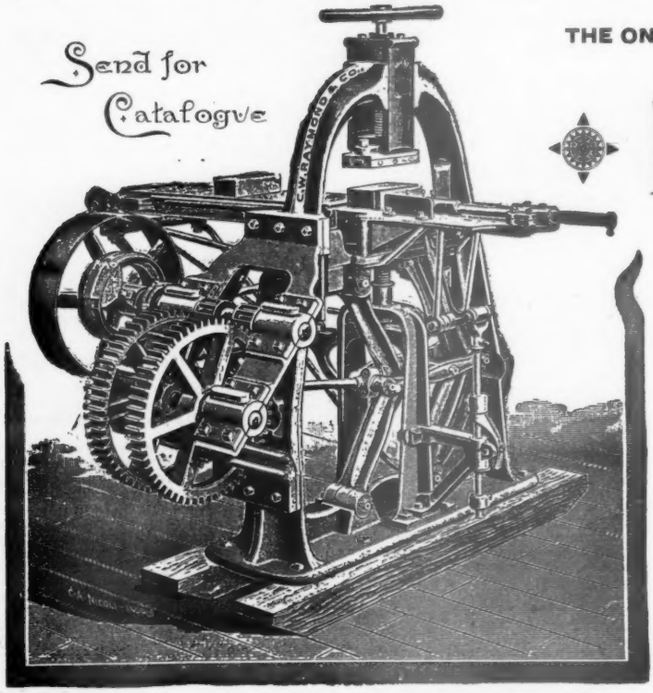

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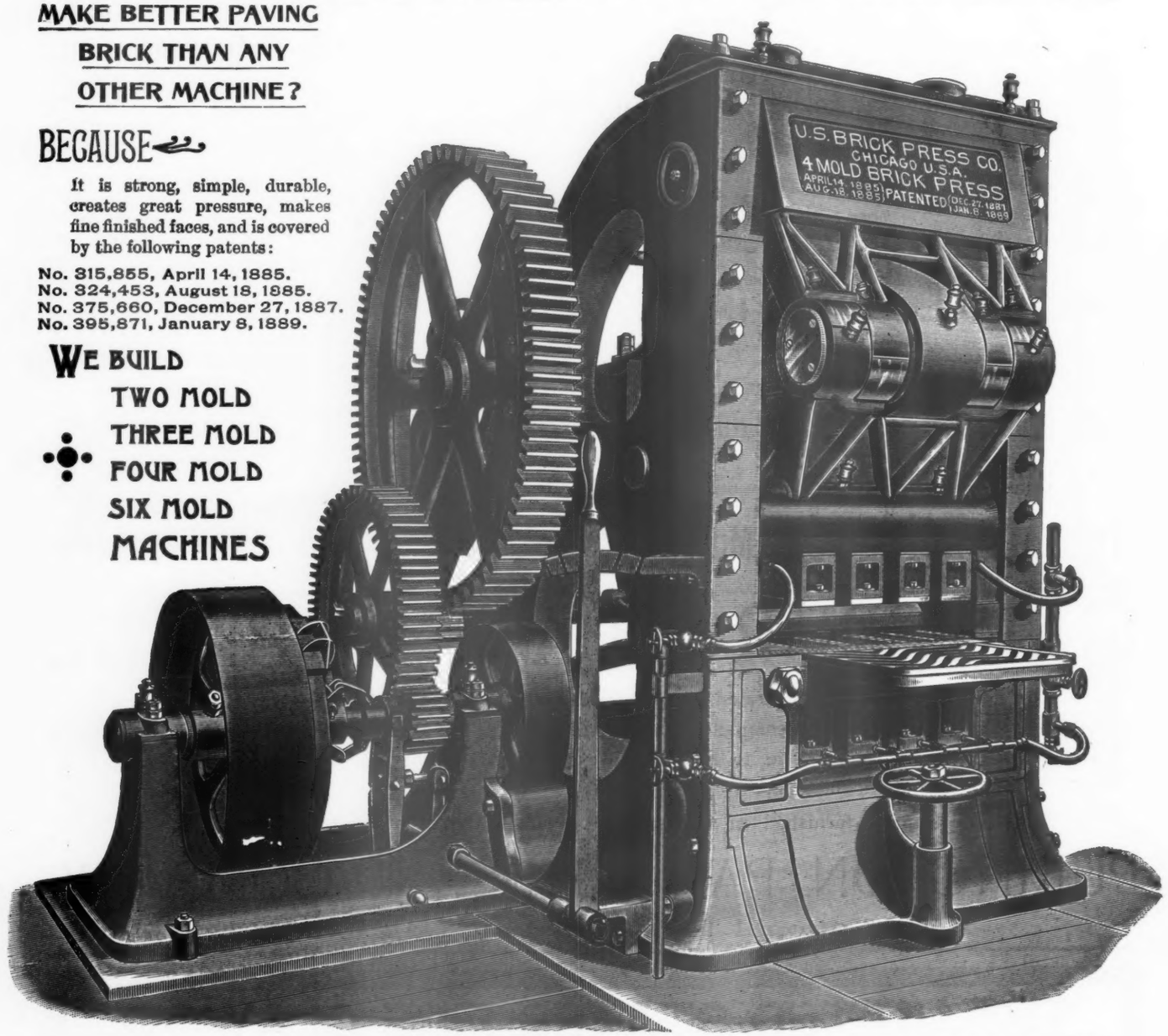

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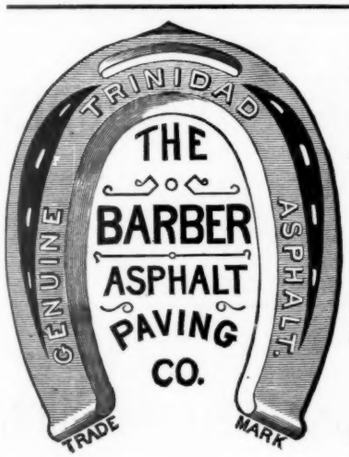

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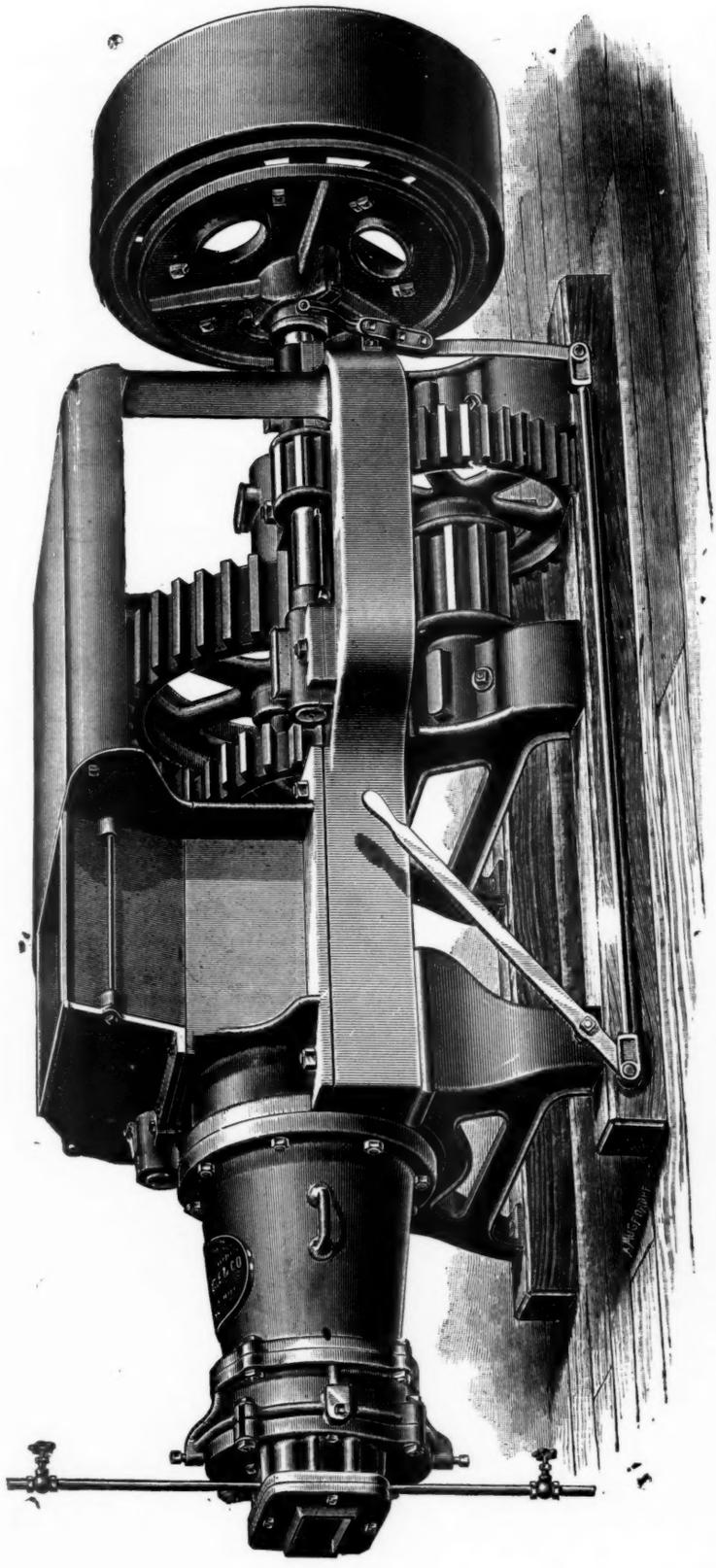

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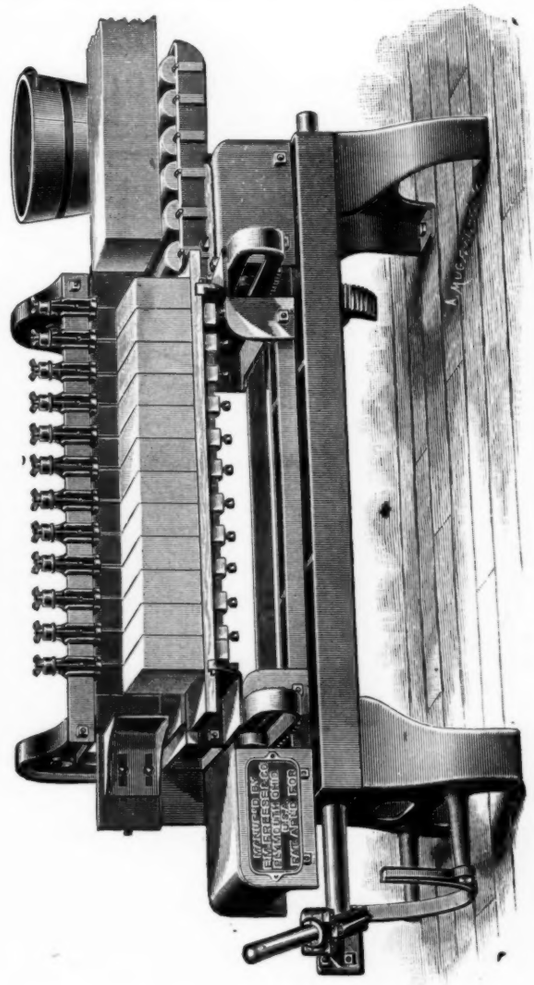

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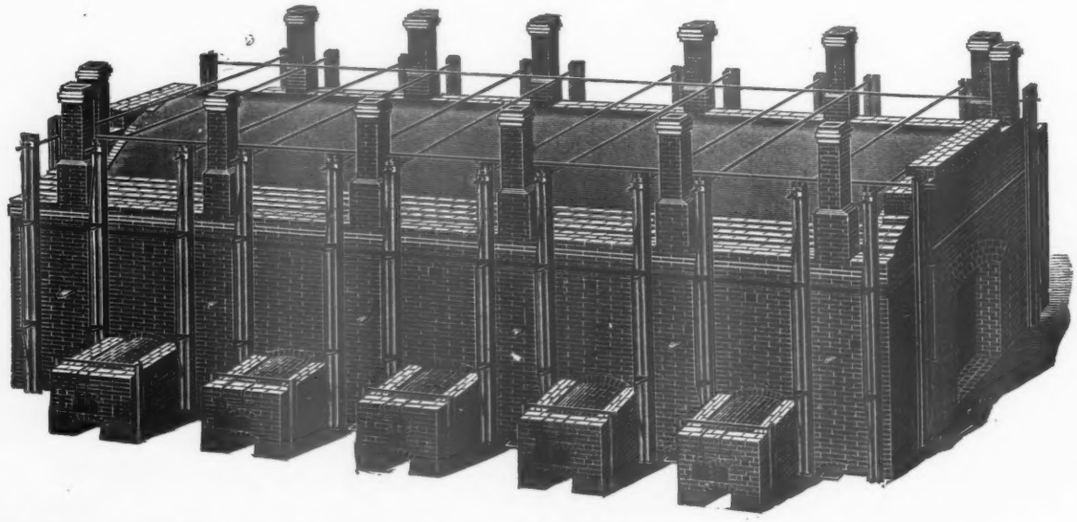

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